USArmy ManTechJournal

Productivity Growth In The 80's

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THE DEPUTY SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

May 30, 1980

MEMORANDUM FOR THE SECRETARIES OF THE MILITARY DEPARTMENTS

SUBJECT: Manufacturing Technology Program

Each of you is aware of the critical production problems we are facing with acquisition and life cycle costs, long production lead times, and shortages of strategic materials. While we have addressed these problems from every conceivable aspect, many remain today. Therefore, we must make a renewed attack on these problems with sustained, new initiatives.

Use of technology to reduce manufacturing costs and to help in the resolution of our other production base problems is a major Research, Development and Acquisition Program initiative for the 1980's. The DoD Manufacturing Technology Program is spearheading this thrust; the attached Statement of Principles outlines its foundation. Its basic objective is to improve the productivity and responsiveness of the defense industrial base by sharing with industry the risks and costs of establishing and applying new and improved manufacturing technologies.

Improved productivity not only exerts tremendous positive leverage on defense systems acquisition and life cycle costs but also is a basic element of economic growth. It is intimately related to inflation, unemployment and the competitiveness of U.S. products in both domestic and world markets. There are numerous examples where Manufacturing Technology Program spinoffs into the overall economy have significantly increased productivity. A classic example is the development of numerically controlled machine tools. Their application in the defense and private sectors has saved billions of dollars in metal removal costs.

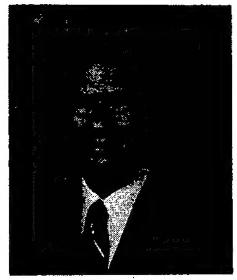
I am convinced the aggressive implementation of the initiatives outlined in the Statement of Principles will significantly aid in the reduction of acquisition and life cycle costs. I solicit your personal assistance and involvement in carrying out this program.

Within 120 days I would like for you to arrange for a briefing for the Under Secretary of Defense for Research and Engineering who will then summarize for me the steps you have taken to pursue the individual elements of the Principles. In addition, I would appreciate learning about any specific major initiatives you have undertaken within this program and any additional ideas you may have for increasing manufacturing productivity and reducing manufacturing costs.

W. Graham Claytor, Jr.

W. Graham Claytor, Jr.

Attachment



DR. ARDEN L. BEMENT, JR., is Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology). He is responsible for overall management of the science and technology programs of the Department of Defense and for related activities such as manufacturing technology and monitorship of the DoD in-house laboratories and Federal Contract Research Centers. From 1976 through 1979, Dr. Bement was Director of Materials Sciences, Defense Advanced Research Projects Agency, responsible for research in structural, optical, and electronic materials for advanced defense systems. During the period 1974-76 he served as a member of the U. S.-U. S. S. R. Bilateral Exchange Program in Magnetohydrodynamics and organized and was principal investigator of the MIT Fusion Technology Program. In 1970 Dr. Bement joined the faculty at MIT as Professor of Nuclear Materials and developed academic and research programs in support of advanced energy conversion technologies. With the change of contractor for the Hanford Laboratories from General Electric to Battelle Memorial Institute by the AEC in 1965, Dr. Bement advanced through a series of management positions to Manager of the Fuels and Materials Department, 1968-1970. He began his professional career in 1954 as a research metallurgist and reactor project engineer with General Electric at the Hanford Atomic Products Operation. Dr. Bement earned a B.E. in Metallurgy at the Colorado School of Mines in 1954 and advanced degrees in Metallurgical Engineering (M.S., U. of Idaho, 1959; Ph.D., U. of Michigan, 1963). Dr. Bement is a fellow of the American Nuclear Society, American Society for Metals, and the American Institute of Chemists.

The Need to Document Program Payback

"If You Use It, Tell Us!"

This special issue of the ManTech Journal for the 12th Annual Manufacturing Technology Advisory Group Meeting offers a unique opportunity to reach a broad range of the DoD Manufacturing Technology Program (MTP) community—both military and civilian. This community is familiar with the broad scope of the day to day problems of American industrial life—inflation, high interest rates, shortages of materials, long lead times, and high energy costs, just to name a few. Most of it is also familiar with a problem which does not press them specifically each day but which is slowly building up pressure and could cause long term, serious harm to the nation—the slow rate of industrial productivity growth of the United States relative to that of our international competition. Conscious awareness about this problem is also slowly occurring outside the industrial base and by the American public in general.

However, many still remain complacent about it because our high standard of living reflects that in absolute terms we are still the most productive industrial nation in the world. But we may not be on top for long! Our industrial competitors in the world markets are increasing their levels of industrial productivity at faster rates than we are

and one or more of them may soon exceed us in absolute productivity levels. Over the long term, unless these trends are modified our standard of living and our ability to defend ourselves as a nation will suffer. We need a strong, modern, productive industrial base to compete in world markets and to defend this nation.

The DoD MTP community is aware of this problem, for the contemporary literature has repeatedly provided facts supporting these trends. The question is: **What is being done about it?**

A Major Program Management Goal

The MTP is a key initiative directly aimed at this problem. The MTP is a major initiative intended to improve the productivity and responsiveness of the defense industrial base. Many have suggested that the MTP is an example others should follow. Yet others have said, "I hear you; but show me just how much you're improving productivity and reducing the cost of DoD's weapons systems?" Some of our answers to that question need to be strengthened. The main point of this article is that the MTP community (military and civilian) needs to strengthen the documentation of where project results are being implemented and the value of benefits being derived from that implementation. In short, the MTP community must document the return on MTP investments. It must demonstrate that the MTP is paying its way in terms others will understand. Strengthening this aspect of the management of the MTP is one of our major program management goals.

The importance of this aspect of the MTP was highlighted in the Statement of Principles agreed upon and signed early this year by both Deputy Under Secretaries of Defense for Research and Engineering and all three Service Assistant Secretaries responsible for the MTP. The SOP is reproduced inside the front cover of this issue. A key element of the SOP suggests that an ROI consciousness be developed and maintained throughout all levels of management. A second key element requires that the MTP be evaluated and payback demonstrated in unequivocal terms.

Services' Approaches Differ

Each military department has been asked to establish procedures to routinely document implementation of project results and benefits that have been achieved. They are following two basic approaches. The Army and the Navy are surveying industry one year after project completion and will document implementation/benefits identified. The Army has established a data base to keep track of this information. The Air Force is using a different approach which requires their new contractors to identify whether or not they have implemented results of a list of previous MT efforts identified by the Air Force. Neither of the two approaches have been in place long enough to evaluate their effectiveness and their pros and cons. The Army's first implementation/benefits report is scheduled to be available by the time of the MTAG Annual Meeting.

Thus, we apparently have the problem solved. But it is one thing for the services to agree to collect this information and it is quite another for them to do it effectively. The very nature of the technology transfer and diffusion process tends to frustrate even the most well intended project tracker. At the very basic level, the output of the MTP is information—whether it be embodied in a paper, a report, a film, or a magnetic tape. In all of these forms it can easily be passed along time and time again through several tiers of communication. The DoD is never sure who has the results from the MTP nor, more importantly, who is actually using them in one form or another for some benefit. What's more, other than in very few cases, no one is under any obligation to tell the DoD they have used the information. Thus, a corollary to the main point of this paper is directed primarily at our private sector colleagues; if you use the results from the MTP, tell us about it.

Size of Task to Double

Just how large is the tracking problem? Figures 1 and 2 show the total DoD and each service's funding for a ten year period (data as of July 1980). During the period from FY 77-81, DoD invested roughly $640 million in the MTP. Our plans call for nearly double that or nearly $1300 million during the next five years, FY 82-86. While one could select several values for an average size MT project, depending upon his assumptions, data from a recent Army report indicates their funded efforts average roughly $450K/year/project. Using this as a basis, DoD will support 2800 projects during the

next five years. By deleting multiple year efforts, one could assume 2000 projects over five years, or 400 per year. Thus, the procedures established must be capable of tracking this volume of effort.

If one knew the names and addresses of twenty people who knew the results of only one project, it would be a large task to survey them each year to ask if they had used the project results and, if they had, what the benefits and payback had been. One might expect some short, direct answers.

Thus, it may appear that the job is impossible. Clearly, it is not—for I will illustrate by means of examples how MTP payback can be documented.

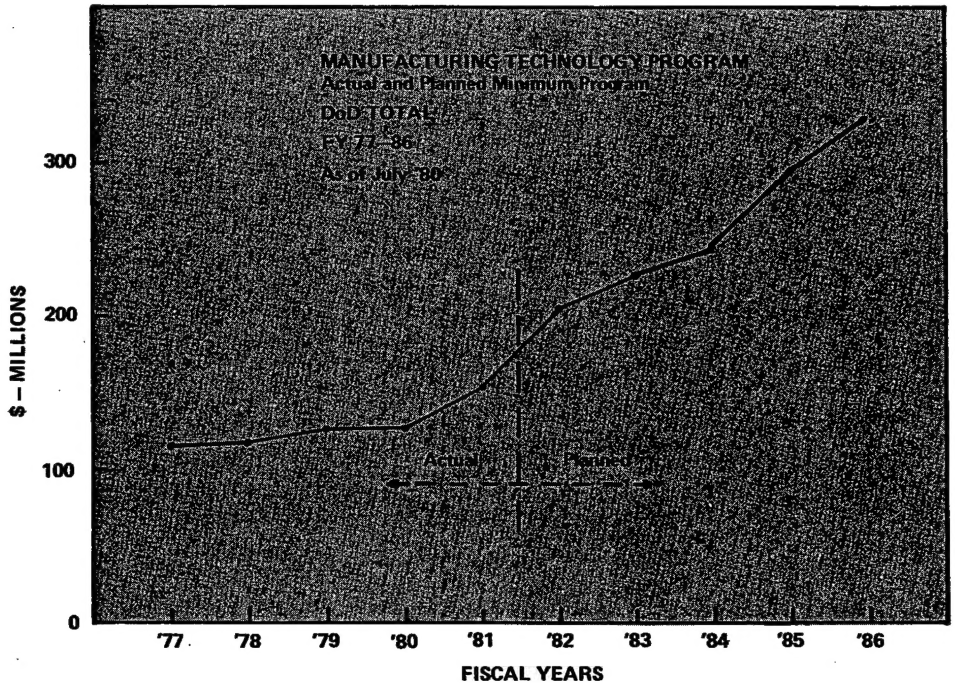


Figure 1

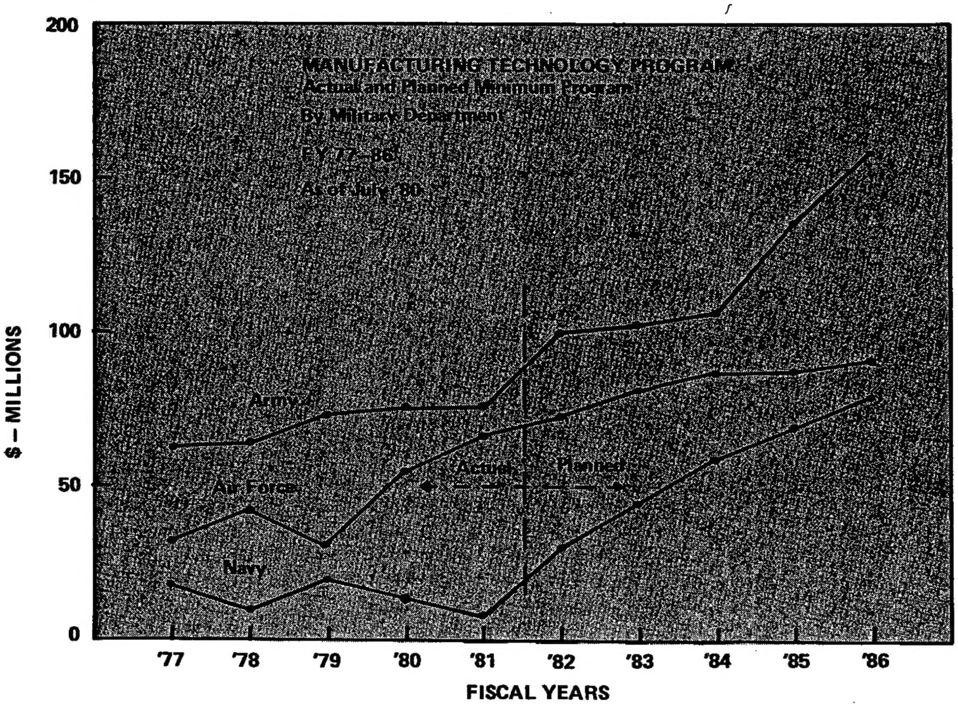


Figure 2

Tenfold Payback

Several years ago the Army became concerned over the cost of a titanium compressor housing for the T700 engine. Its method of manufacture consisted of forging two halves of the housing, machining both halves to the correct size and then welding and bolting the pieces and accessories together. The Army invested MTP funds in a new approach employing precision centrifugal casting of the housing. The project was a technical success and the new approach reduced machining by over 30 direct labor hours per unit. It also reduces the use of high cost titanium, for the casting weighs only 30 pounds while the forging weighed 65 pounds (See Figure 3). The original prediction of a 20 percent manufacturing cost savings on the component has been verified. While the total savings will vary based upon the number of engines eventually produced, it is estimated to be at least $5 million over the production life of the engine. The project cost was one half million dollars.

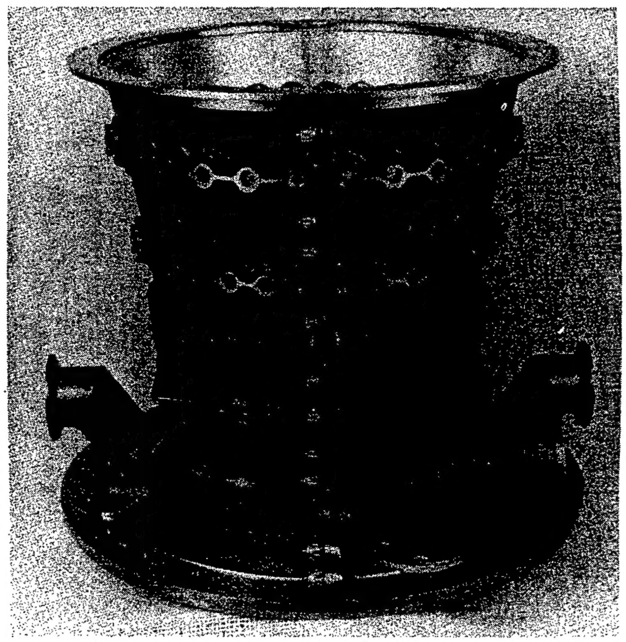


Figure 3

Near Net Shape Ti Channels

A similar success story has been reported by the Navy, dealing with the fabrication of titanium channels for aircraft structural application. Titanium is not the easiest material to fabricate. The original approach was to machine the channels from plate stock. The final 22 pound part was produced from a 240 pound plate by brute force, hog out methods. The next approach involved machining and electron beam welding two "L" shaped extrusions initially weighing 90 pounds. The Navy then invested in an approach to provide near net shape channels from titanium sheet stock by shaping the material between refractory metal rolls using progressive localized heating of both the rolls and the workpiece. The method is especially suited to high aspect ratio (long and narrow) shapes. It has been shown to reduce scrap by 50-90 percent and reduce lead time from 80 to 24 weeks for structural parts, while simultaneously reducing the cost of capital equipment necessary to do the job. In the example cited above, the rolled part weighed only 39 pounds (see Figure 4). Navy invested roughly $750K but estimates savings of over $6 million on only two major aircraft procurements.

HIP Improves Casting Properties

Payback from an Air Force MT project has produced similar results in the overall production base. In turbine engines there is always a natural tendency to want to use cast parts instead of forgings, for castings in general lower costs. However, castings typically have lower physical properties (by as much as 50%) and have a wider range of

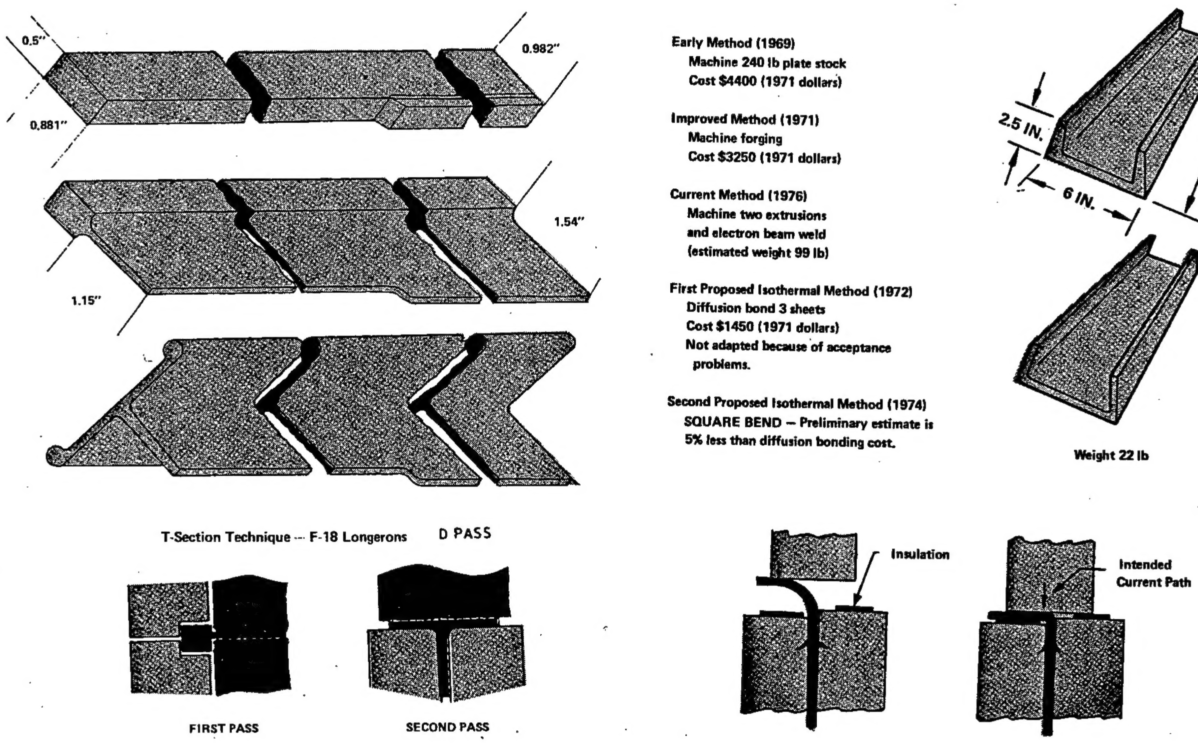


Figure 4

properties than forgings. However, castings can be produced closer to net shape and thereby save high cost/scarce materials and machining costs. A method was needed to improve the properties of castings.

The Air Force invested in a hot isostatic pressing (HIP) casting densification (materials property improvement) process applied to jet engine turbine blades. In essence, the cast blades are put into a pressure vessel where they are subjected to high pressure and temperature over a period of time. The resulting casting properties are improved

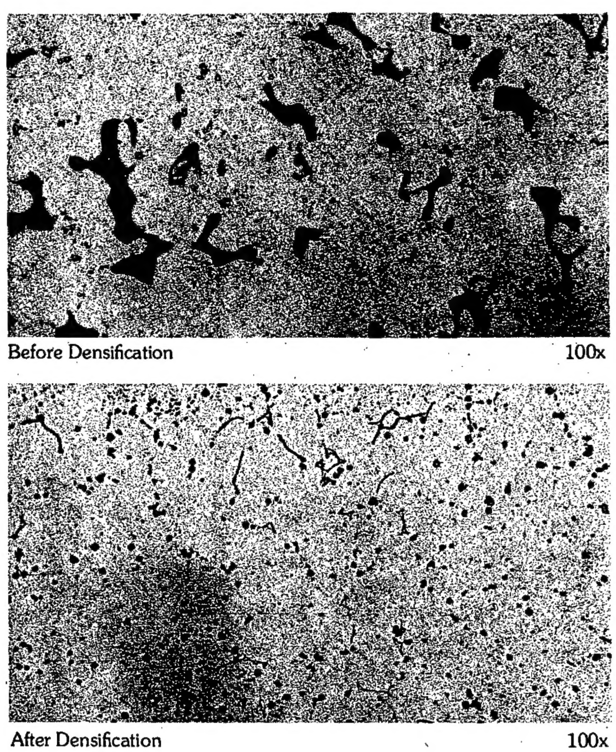


Figure 5

to the point where they can compete successfully with forged blades—and at a much lower cost. To date, over twenty HIP units are in operation in the industrial base and over 200,000 cast turbine blades have been processed (See Figure 5). One major blade supplier estimates his savings at $1.5 million/year.

Laser Drills Holes Easier

The Air Force also has had success reducing turbine blade costs by utilizing laser drilling to produce blade cooling holes (See Figure 6). These 0.008 to 0.050 inch diameter holes at depths of up to 0.750 inch would be difficult to produce in conventional materials, but are even more difficult to produce from high hardness blade materials. After completion of two MT projects, laser drills have been and will continue to be used in routine production. They reduce drilling costs from 20-90%, depending on the blade design; one contractor estimates his savings at $1.5 million/year. In addition, the maturation of the process will permit new design concepts for turbine blades to be evolved.

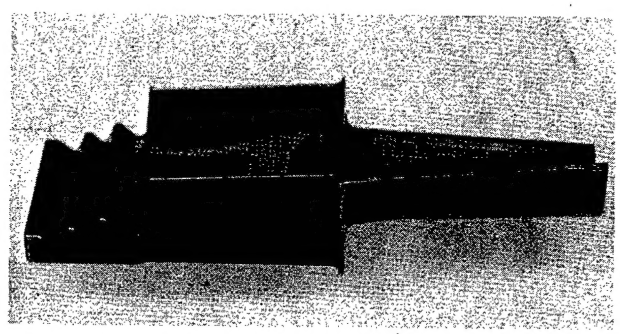


Figure 6

Foam Filled Radomes

The range of the scope of the MTP is very broad, and many varied materials and processes are candidates for cost reduction. For example, the Navy invested in a new process to substitute foam filled radomes for honeycomb structural radomes. The honeycomb units required a heavy capital outlay for autoclaves, vacuum systems, bonding presses, and high cost tooling and material. An R&D effort demonstrated the feasibility of using foam filled radomes which offered a 20:1 cost savings over honeycomb while retaining excellent transmission characteristics and superior weather resistance (see Figure 7). The MTP investment reduced the cost of PHALANX radomes by an order of magnitude. The $116K investment saved $405K on FY 78 procurements and is expected to save over $4 million more on scheduled Navy procurements through 1984. The same processes are applicable to similar radar applications in all three services.

Detonator Loading Automated

Perhaps one of the greatest areas of MTP savings is in the ammunition business. In this area, even a small unit cost savings can amount to millions of dollars quickly because of the volume of ammunition produced. One case in point is an Army investment in automated detonator loading. Production is measured in millions of units per month at peacetime rates and an order of magnitude above that for mobilization rates. AUTOMATION IS A MUST. The Army invested roughly $640K in a new automated detonator loader and the device increased production by over 300% per shift (see Figure 8). It reduced mobilization facility requirements by one complete facility, with the attendant cost avoidance of over $30 million for construction and equipment and a current operating savings of over $40,000/month at peacetime rates, with a corresponding greater savings at mobilization rates. In addition, the device enhances personnel safety by sharply reducing the number of people exposed to explosives during the loading process.

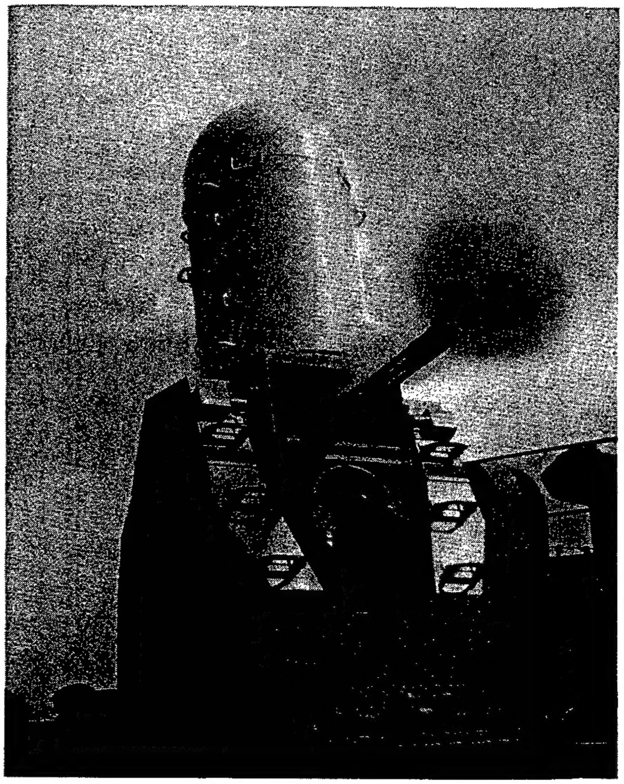


Figure 7

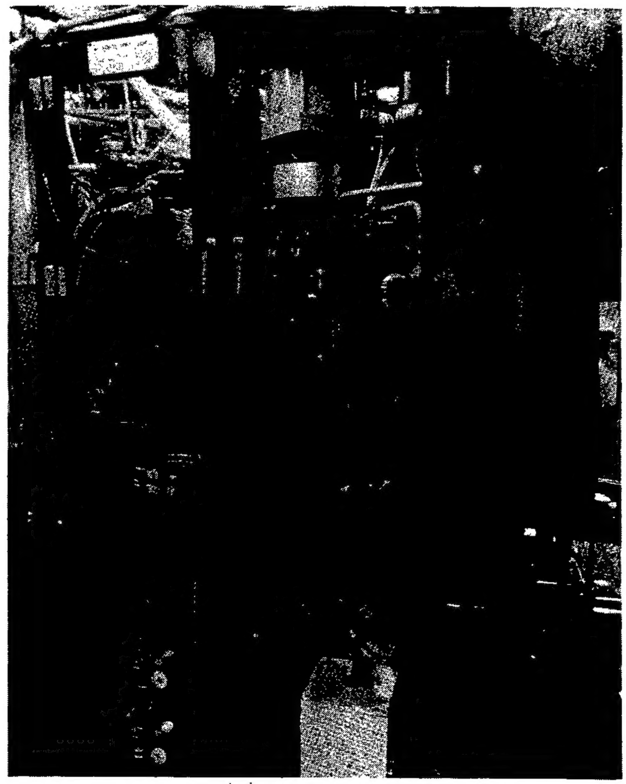


Figure 8

Timely Data, Cooperation Needed

The six examples cited above are illustrative of the roughly thirty examples of MTP payoffs presented to the MTAG Executive Committee last spring. The individuals responsible have a right to be proud of their contributions. These cases illustrate that tracking and documentation of implementation and payback can be accomplished if these key elements are in place:

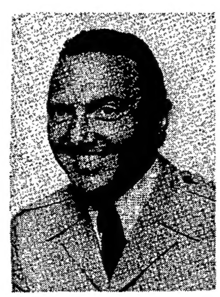
(1) Everyone in the DoD MT community understands that payback documentation will be required from the onset. This will motivate every level of management to establish procedures to make sure that data is collected in a timely manner rather than helter skelter in a catch up mode two years after the fact.

(2) The private sector is provided the rationale for (and fully appreciates the need to positively respond to) MTP managers' requests for information. Success stories are equally as welcomed by private sector managers as by the DoD.

Project Followup A Responsibility

In summary, there is a need to strengthen the payback reporting procedures of the Manufacturing Technology Program. It is a stiff challenge, but it can be met if we as managers of the industrial base motivate ourselves and inspire our colleagues to develop an ROI consciousness and to always remember that project followup is an essential part of program management. The citizens of the nation will invest over one billion dollars in the MTP in the next five years. A one billion dollar investment can have a very positive impact on the nation's industrial productivity and on the nation's defense. It is our responsibility to report back to the citizenry how wisely we have invested their money.

Improving Productivity Through ManTech



JOHN LARRY BAER joined the Office of Manufacturing Technology at the U. S. Army Material Development and Readiness Command in September 1976, bringing with him over 24 years of experience in advanced material development. After serving at Picatinnny and Frankford Arsenals and at the U. S. Army Limited War Laboratory, he became Chief, Advanced Concept and Technology Division at the Small Arms Systems Agency in 1969. He took over the Weapons Systems Synthesis Division in 1971, headed the LWL Chemistry Branch in 1973, and was part of AMSAA R&D Field Liaison Division prior to joining Headquarters, DARCOM. Mr. Baer holds a Bachelor of Chemical Engineering Degree from CCNY, a Master of Science Degree in Chemical and Industrial Engineering from Iowa State, and a Master of Business Administration Degree from Temple University. He is a registered professional engineer and a recipient of the Army Meritorious Civilian Service Award. Mr. Baer served as acting chief of the OMT from June 1978 until January 1979 and now directs its Chemical and Mechanical Engineering Division.

Documentation Tells the Story

United States defense firms are operating with a shortage of skilled personnel, aging equipment, and constantly growing requirements for occupational safety and health and for pollution abatement. They are facing accelerating competition from overseas by dedicated workers, new and efficient machinery, and growing export demand. These problems can be offset by our improving productivity through development and use of the latest manufacturing technology concepts and principles, which are within our grasp through the Army's manufacturing technology program.

Manufacturing methods improvement has been the key to increased productivity since the beginning of the industrial revolution. However, a centralized Manufacturing Technology (MT) program for the defense establishment, as outlined elsewhere in this issue, is less than 17 years old. In this brief review, we will cover the Army's approach to and objectives for the MT effort and summarize several of the most significant projects.

A major impetus for the Army's MT program came from the 1975 guidance of then Deputy Secretary of Defense Clements. His direction was for a centralized office to manage the transition from hand crafted development models to low rate initial production of all Army commodities by identifying and exploiting MT cost reduction opportunities.

Utilization

The scope of the Army's MT thrust is illustrated by the list of commodities and technologies of interest in Figure 1. Note that present program emphasis is on end item development—i.e., MT projects should be directed toward increased productivity of a specific item and only secondarily to more generic applications. However, spinoffs applicable to other commodities will obviously result. The Army's MT Office provides the expertise for effective program management in all those areas listed. However, success of the program depends largely on the MT offices and project engineers in the

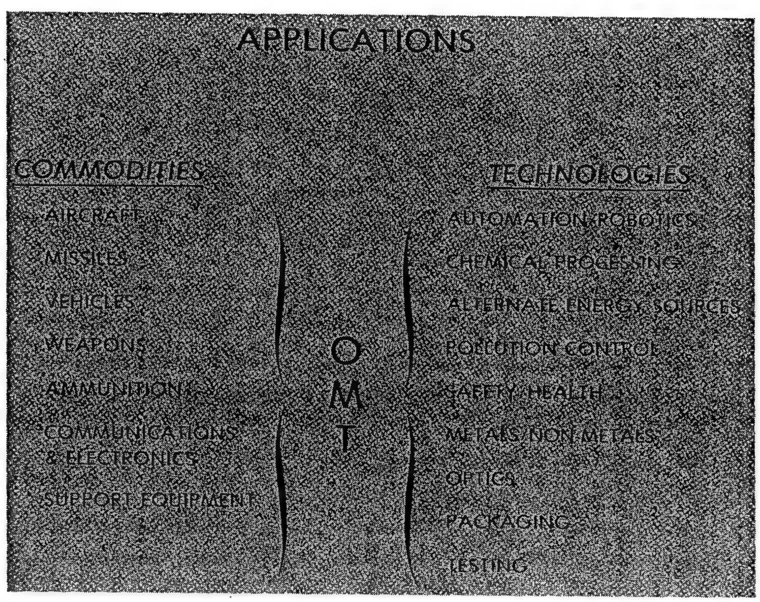


Figure 1

field and their counterparts in industry. The generation of project proposals and the performance of MT projects—whether the fruit of Government engineers or the product of industry—are, however, only precursors to implementation.

Unless they are effectively utilized, the results of MT projects are like wax fruits in a basket—ornamental but not nourishing. However, just how well they are utilized is sometimes hard to determine. Like a wholesaler, the Army can usually trace the project only to the first buyer. The flow of MT projects from concept to execution is illustrated in Figure 2. Working through the Industrial Base Engineering Activity (IBEA) and the Manufacturing Technology Advisory Group (MTAG), the Army is now attempting to document first applications and, through followup reporting, to trace additional implementations.

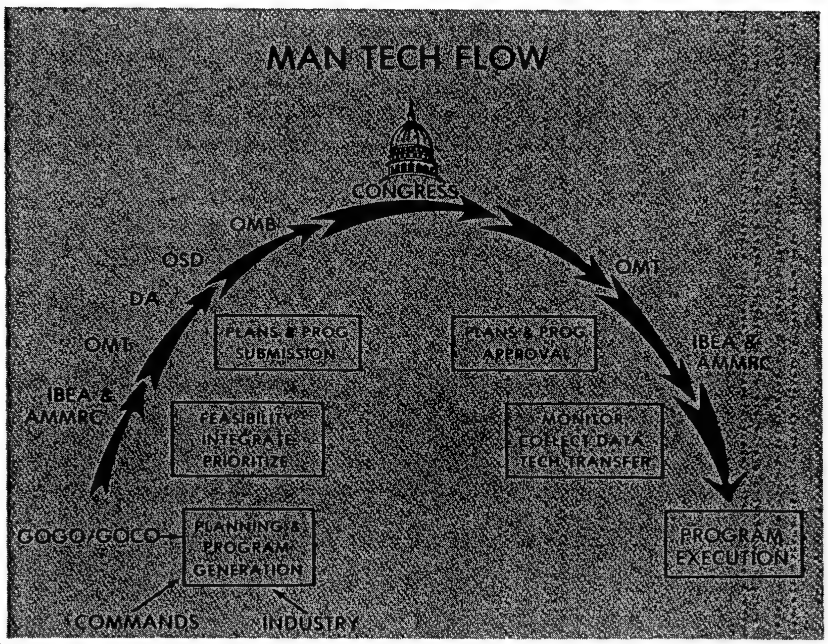


Figure 2

These reports will become a part of the Army's MT Management Information System, illustrated in Figure 3. Here, industry cooperation in careful reporting and documentations of results becomes important. IBEA can only ascertain whether the technology transfer seeds have fallen on fruitful soil if industry adknowledges its utilization of these tax supported MT project results. Hopefully, readers of this article and those who will hear this message at many symposia will heed this call for implementation reports.

Constraints

Along with the thrust away from extensive program planning review and toward

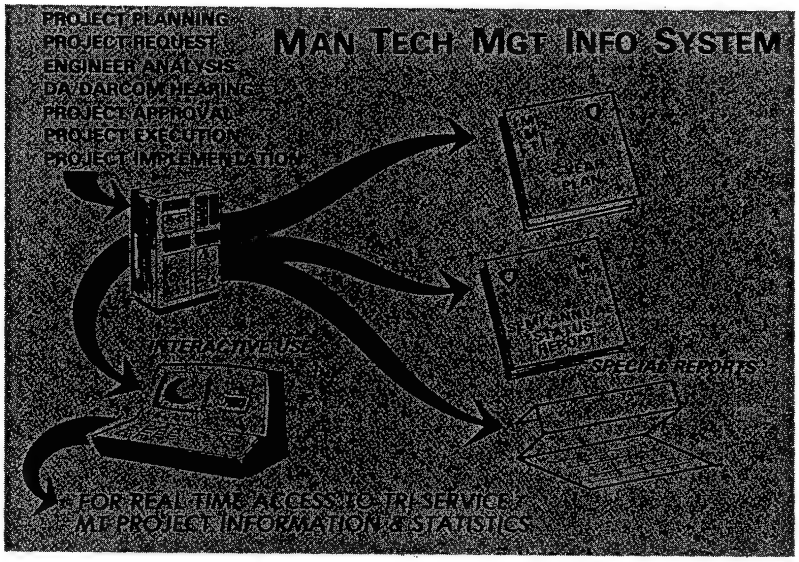


Figure 3

greater emphasis on implementation, we must recognize that the MT program is evolutionary, not revolutionary. Resources cannot pour directly into improved producibility. As seen in Figure 4, there is a valve in the line controlled by certain constraints. The real need is to assure our readiness for manufacturing military hardware from a warm or laid away cold base with minimum lead time and to reduce production costs for increasingly complex materiel in the face of shrinking budgets. However, the MT program faces serious restraints in safety and health regulations, pollution abatement requirements, and the urgent need to conserve energy and critical raw materials, frequently with less than skilled workers.

The Army's MT objective is to develop and implement manufacturing processes that emphasize energy efficiency, pollution abatement, and computer control. Although necessary, program improvements in safety, energy, and pollution hardly seem to be the stuff of enhanced productivity (the ultimate MT goal) or quantifiable cost benefit. Yet, in most cases large savings are clearly evident and without many of these MT projects to date production could have been completely halted pending conformance to the appropriate regulations. Most savings in the manufacture of Army procured materiel have been achieved through the design or adaptation of special purpose equipment, processes, or material. A goodly amount, however, has resulted from reduction of needed resources, such as raw material, water, or energy. Let's consider some of the past programs.

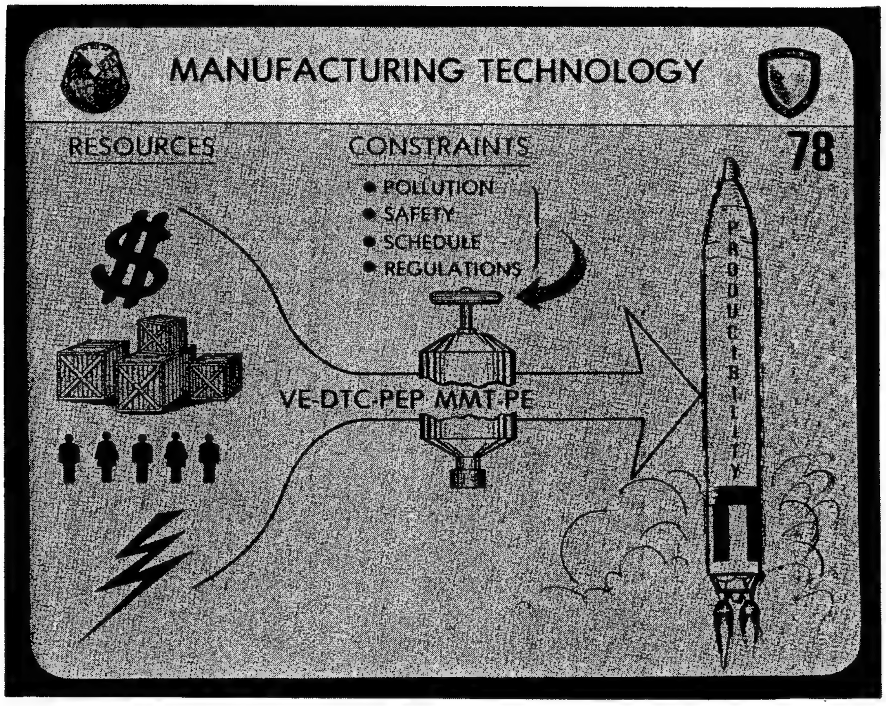


Figure 4

Forming Developments

Development of hot isostatic pressing for near net shape forming probably has the broadest application to the array of Army commodities supported through the MT program. Savings on the Army's T700 turbine engine alone are estimated at $3.7 million. Parts have improved low cycle fatigue. An adjunct process, isothermal powder metal forging, has demonstrated threefold improvement in material utilization (and hence vast reduction in scrap) and has reduced the number of machining steps by 50 to 65 percent. As a result, 50 percent cost savings have been realized through MT programs for items from simple vehicle yokes to precision turbine blades and vanes. The potential for enhanced, low cost producibility with this process is limited only by the ingenuity of the designer and production engineer.

In a completely different vein, consider a way in which water was saved through an MT project. The arrangement for effluent handling at Radford AAP not only provided a nice cost avoidance because an $11 million water treatment plant didn't have to be built, but it cut daily water consumption tremendously—from 3.3 to 0.3 million gallons per line. Of course, it drastically curtailed downstream pollution and, as an extra benefit, allows recovery and reuse of 32,000 pounds of salts daily that would otherwise have been washed down the river.

Energy Savings Through Value Engineering

Value engineering is an adjunct to MT efforts that is usually invoked on production processes. Figure 5 illustrates how energy was conserved by utilizing waste heat during nitrocellulose manufacture. The luxury of cheap energy is a thing of the past; the profligate energy consumption in our country at a per capita rate twice that of European nations can no longer be tolerated. We have neither the nonrenewable energy sources to waste, nor can we recklessly pump the waste heat or its concomitant particulate and gaseous pollutants into the atmosphere. Whether through value engineering or through novel MT adjustments to the manufacturing process, we must modify our ways in order to pass on a viable biosphere to the next generation.

Engineers at Watervliet Arsenal demonstrated that a little ingenuity can go a long way to replace the 40 hours of tedious hand filing needed to remove sharp corners in the bore of 152 mm cannon tubes with 2 hours of simple mechanical abrading, using nothing more than a glorified dentist's drill. Similar automated finish grinding jobs, called benching, not only overcome such tedious hand work but also remove the health hazard created by the fine particulate generated as a gun breech block is honed to the fine fit demanded of it. For a project cost of $35,000, the total savings through 1977 were $2.5 million.

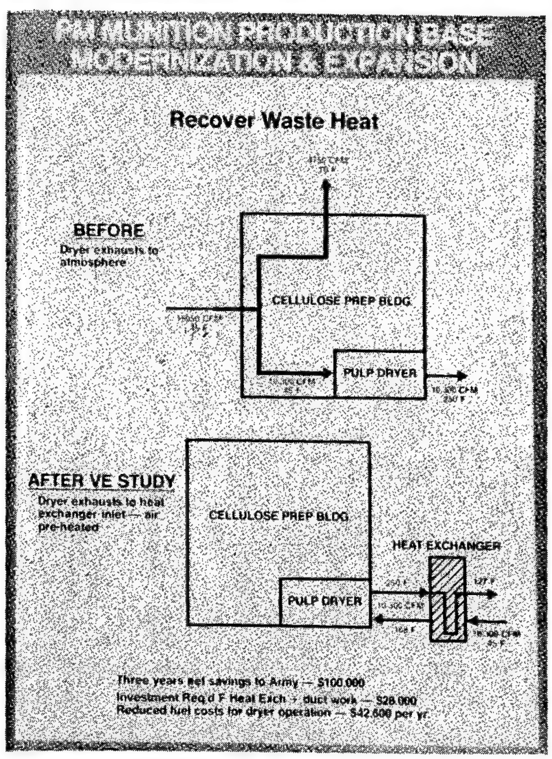


Figure 5

Simulated Test Firing

As the result of an MT program at Rock Island Arsenal, the loads applied on artillery recoil mechanisms and carriages by live firing are now simulated with an impulse generator developed at a cost of $525,000. The load is applied by firing just $3 worth of powder rather than $168 105mm or $256 155mm rounds. And the simulation of applied loads does more than save money and time. This arrangement, which has saved the Army some $12 million in the 8 years it has been in use, also does away with the need for having special ranges, for shipping the gun to such ranges and back for proofing, and for all the labor and paper work connected with such a procedure. Such large scale simulation, carried out to test the effectiveness of our production processes, has application in many areas.

In another program, equipment was developed at a cost of $250,000 for automated inspection of precision fuze parts. This equipment can evaluate the precision with which fuze parts are made much more accurately and rapidly than the human eye ever could—and without fatigue and the deteriorating quality of inspection that goes along with it. It provides printouts of results and can be used for 100 percent inspection when needed. The technique is adaptable to a variety of parts and has already paid for itself many times over.

Cost Driver Analysis

There are two areas where enhanced mechanization of production is critical to improving productivity. The first is in the manipulation of parts that are either so small as

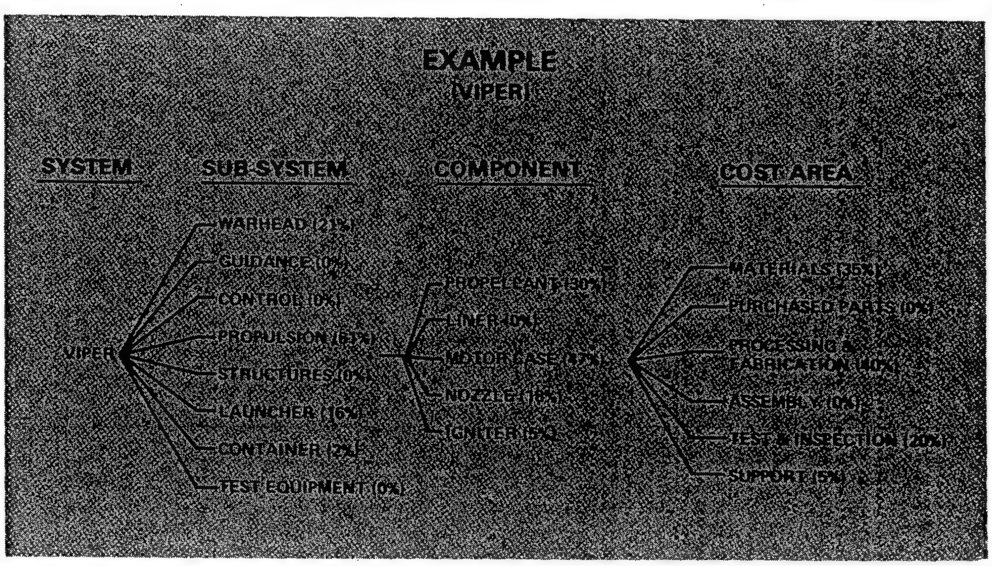


Figure 6

to try the manual skill of the artisan or so large as to require extensive power assist—as for example with large caliber gun barrels or tank hulls. The second is in areas where a cost driver analysis, as illustrated for the Viper missile in Figure 6, has identified a part as contributing a disproportionate percentage of total system cost. Where size or complexity are not self evident justification for mechanization, a cost driver analysis will identify where MMT dollars can be wisely spent. With limited funds, we cannot afford to fritter them away on tasks of limited utility or marginal productivity increases.

Sensing various process parameters can be a critical part of a manufacturing process. However, sometimes even our mechanical aids, superior as they are to human senses, are no match for the pressures, stresses, and temperatures we must use to create the Army's materiel. Such is the case in measuring and controlling the heat input to smelting furnaces. Conventional instruments give only crude estimates of the temperature in or near a molten bath or a tempering furnace and have time lags built in that preclude swift correction of unnecessary overheating. The simple fluidic high temperature sensor shown in Figure 7 overcomes those shortcomings. Using readily available shop air in a ceramic anulus, it provides virtually instantaneous measurement of furnace temperature. This allows rapid adjustment so that no more heat than is absolutely necessary to treat the part or melt the pour is provided.

Development of Automated Systems

Automation frequently lets us do things much more efficiently than we can do them manually. The automated tape layup (ATLAS) of helicopter blades is a case in point,

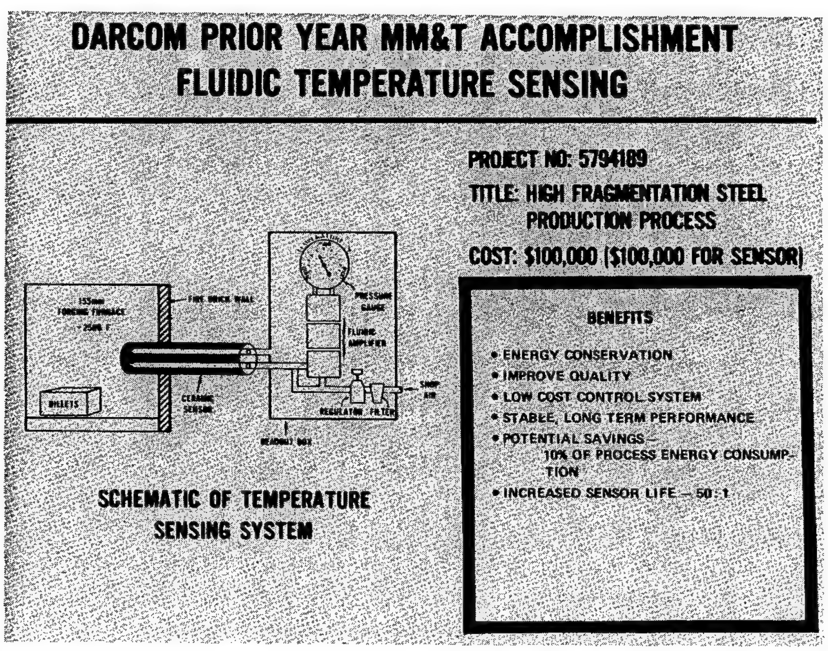


Figure 7

resulting in a cost reduction of $19,000 per blade. During MMT development of this process, a flexible 6 degree of freedom machine was used to demonstrate the potential effectiveness. The 2 degree of freedom machine ultimately used in production has all the necessary versatility to generate a blade with a life expectancy ten times that of the hand laid up version. It also permits field repair of bullet holes or other damage and, by virtue of the smoother layup, generates more lift. These are unexpected, but very welcome, benefits of this automation applicable not only to helicopter blades but also to missile bodies and similar structures.

The same type of process used to lay up helicopter blades automatically, evenly, and smoothly is being considered to replace the hand layup of plies for a helmet. This involves the random laying up of the reinforcing fibres onto a matrix. Merely by virtue of using a continuous fibre rather than cut strands, the helmet is expected to be not only more uniform, but materially stronger and more impact resistant for its weight than the hand laid up version.

Computer Control

A superior product is not always the driver behind MT projects. Sometimes it's the potential loss of certain skills in the labor force. Such a skill is reticle scribing in the manufacture of fire control instruments. Even with the pantograph, which permits simultaneous creation of ten uniform reticles, a sneeze or hesitation that mars one part mars all ten.

In an MT program, a computer-controlled engraver was developed to do this job. Applicable to reticles for binoculars, periscopes, telescopes, and range finders, it saves 60 percent of preparation costs and 50 percent of labor costs. Automated scribing can do the job faster, more uniformly and more reliably—hence more efficiently than the fast disappearing craftsman. Not only do we acquire greater productivity, we also generate a computer capability to fill in for the craftsman when he's sick, when he retires and there's no replacement, or, more importantly, if a sudden mobilization requirement overloads the available capacity.

Computer controlled manufacture on a much larger scale was developed during the Small Caliber Ammunition Modernization Program (SCAMP), which involved automation of the complete production, testing, and packaging facility. Automation, at a cost of $18 million, has eliminated over a period of 8 years the crude methods, the dirt, the waste, and the human wear and tear needed to make small caliber ammunition in the past. SCAMP doesn't produce the small caliber ammunition as cheaply as predicted yet. But when the rent and overhead have to be paid to produce 5 to 6 million rounds per month on a machine system designed to operate at a minimum rate of 7 million rounds, price has to be sacrificed until the system can be brought up to speed and is completely debugged. The productivity enhancement potential is irrefutable, with projected savings of $45 million over 10 years when the lines are fully operational.

Long Range Planning

This gives you some idea of the scope of Army MT efforts and the significant accomplishments to date. With the improved MMT project monitoring provided by the MT Management Information System at IBEA, the Army can now pay closer attention to tracking and implementing successful MMT projects and at the same time improve future planning. Figure 8 shows one approach to long range planning.

The productivity growth picture, so dismal for the U. S. overall, is really fairly good in the manufacturing sector, which was able to boast an annual 1.7 percent growth rate for the years 1973-78. Even while the non farm business sector productivity has

declined steeply, the productivity in the manufacturing sector of the economy managed to rise at an annual rate of 3.3 percent during the 3rd quarter of 1979. It is factors like these that have caused foreign firms like SONY to build plants in the United States, citing lower transportation and raw materials costs and lower utility and tax rates than in Japan as incentives, as well as **good worker productivity**. While Japan, France, Sweden, the United Kingdom, and Germany are fast approaching U. S. productivity at growth rates exceeding ours, they still lag behind our industrial productivity in terms of output per man-hour.

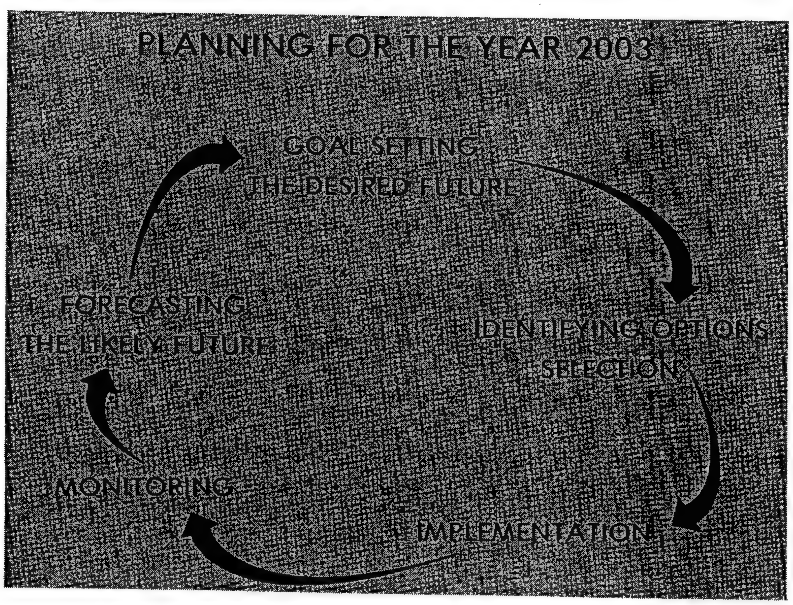


Figure 8

MT Budget Forecasts

As indicated in Figure 9, the forecast for the Army MMT budget is one of modest increase commensurate with modest growth in procurement of military hardware. However, this budget will permit the funding of many worthwhile projects in both government laboratories and to a greater extent in private industry. Peacetime savings over the next 5 years from MT projects already completed are estimated at $530 million. A few individual projects, like ATLAS, have projected 10 year savings that would pay for the whole MT program over the last 10 years by themselves.

An area that can be expected to impact on MMT is international technology transfer. The U. S. cooperates, and at the same time competes, with industries in friendly, allied and maybe even "unfriendly" or third world nations. In an increasing number of areas, overseas industries have developed unique and often superior technologies that we

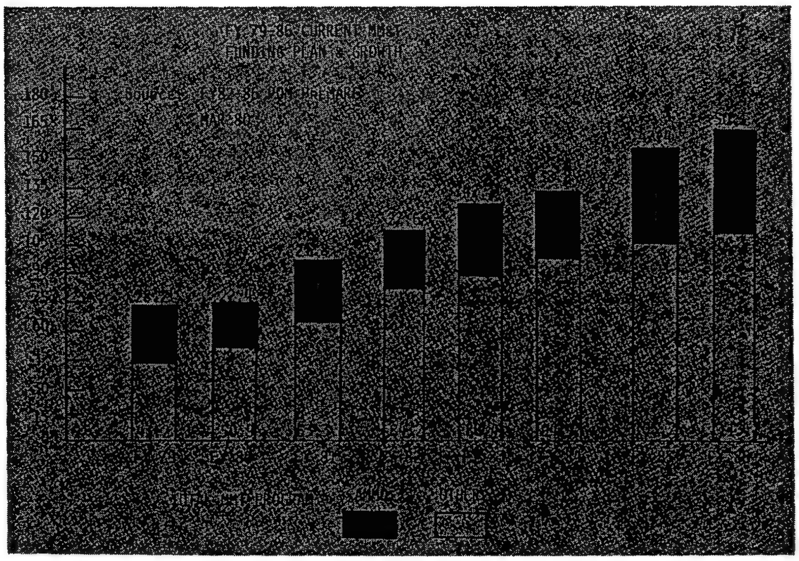


Figure 9

have eagerly adopted or are obliged to use. Examples are the Austrian Rotary Forge, Swiss Conicell NC Purification system, and Swiss carbide hobs. We must continue, for our national well being, to seek out and utilize the best foreign manufacturing technologies. At the same time, we have the moral obligation to share some of our technologies with our allies, while carefully scrutinizing and protecting critical technologies from inadvertent transfer to unfriendly nations through third country sales.

Implementation

In summary, the Army's MT goals are consistent with Congress' and GAO's concerns:

- Maintain close control on project selection and prioritization
- Follow up to ensure successful completion and utilization
- Improve implementation and its documentation through the implementation plan.

An implementation plan and road map are now required with all P-16 project proposals to cover the activity up to and through the final implementation follow-up. The Army will work closely with industry counterparts through the Manufacturing Technology Advisory Group and all its subcommittees for a stronger free world and a more productive America.

Navy MT Stresses Interaction

CAPTAIN FREDERICK B. HOLLICK, USN, is the Director of the Navy's Manufacturing Technology Program. He graduated from the U. S. Naval Academy in 1952 and served a tour of sea duty with the Amphibious Forces prior to entering the Flight Training Program. After receiving his wings, he served with various carrier based Anti-Submarine Warfare Squadrons. He attended the Navy's postgraduate school at Monterey, California, and after receiving a B.S. Degree in Electronics Engineering, served in Air Development Squadron ONE (VX-1) as a Sonics Systems Project Officer. Shore based tours included Project Officer of Shipboard ECM systems while on the staff of Commander, Operational Test and Evaluation Force; a tour at the Naval Academy teaching Electronics Engineering; and several tours in OPNAV involving RDT&E in the Tactical Air Warfare Branch and later in the Reconnaissance and Surveillance Branch. CAPT Hollick has been in his present assignment since October 1979.

Return on Investment of 6 to 1

The Navy considers Manufacturing Technology (MT) to be an important discipline with a demonstrated potential for reducing procurement and life cycle costs and for increasing productivity by establishing new or improved manufacturing processes for the production, overhaul, and repair of Navy weapons.

Directed At Cost Reduction

The Navy MT Program objectives center on reducing acquisition costs for material to support current and projected fleet needs. Specific objectives are to

- Reduce acquisition and life cycle costs of Navy systems.
- Promote and establish improved processes, methods, techniques, and equipment for the most efficient and economical production of defense material.
- Provide the technology required to advance manufacturing capability.
- Stimulate industry to implement and invest in new manufacturing techniques.
- Provide maximum dissemination of the results of manufacturing technology projects and promote early implementation.
- Strengthen the defense industrial base.

As shown in Figure 1, the MT Program is centrally managed by the Program Director under the direction of the Chief of Naval Material. The Naval Material Command Industrial Resources Detachment (NMCIRD), located in Philadelphia, provides technical review, technical coordination, and administrative support. Each Systems Command (Naval Air Systems, Naval Electronic Systems, and Naval Sea Systems) has a manufacturing technology office to support the MT Program Director. These offices are responsible for planning, executing, and implementing the portion of the MT Program that falls within their area of interest. The Navy Field Activities, such as laboratories and engineering centers, support the three Systems Commands directly through engineering efforts or contract monitoring.

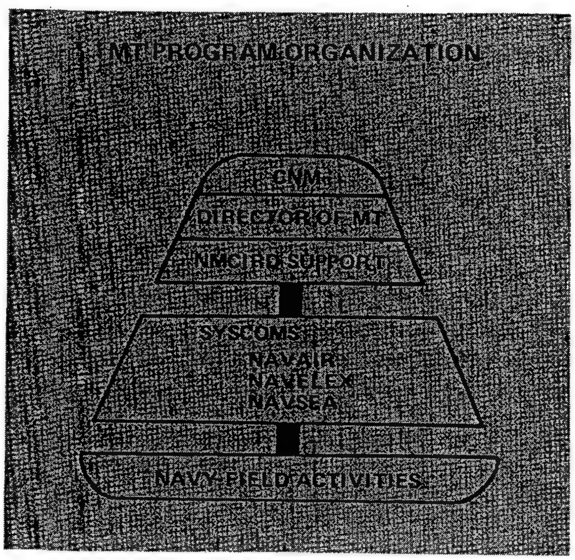


Figure 1

Proposals Welcome

Participation in the Navy MT Program is open to all. Both government and private sector involvement are required to meet the challenge of providing the necessary quantities of sophisticated new weapon systems under projected austere budgets of the future. Emphasis is placed on technological innovations that directly relate to defined Navy needs. As can be expected, the Navy will not support efforts that exclusively benefit the commercial market. However, technologies largely in support of defense requirements frequently have commercial application.

To provide a semblance of order to the input for this wide ranging program, there are some specific guidelines for manufacturing technology proposals. To be considered for funding support, projects should

- Satisfy a current or anticipated Navy need.
- Be designed to establish new or improved producttion and overhaul technology; the mere application of existing and proven technology is not sufficient cause for active consideration under this program.
- Involve a technology whose feasibility has been demonstrated at laboratory or higher levels and that shows a probability of success in industrial application.
- Not knowingly duplicate other efforts available or under development for Navy use on a timely basis.
- Be beyond normal industrial risk.
- Generally pay for themselves (self amortize) within a five year period, starting with the initial year of funding.

Designed For Interaction

Figure 2 shows how the organizational elements in the MT Program interact with themselves and contractors to generate projects in response to Navy needs.

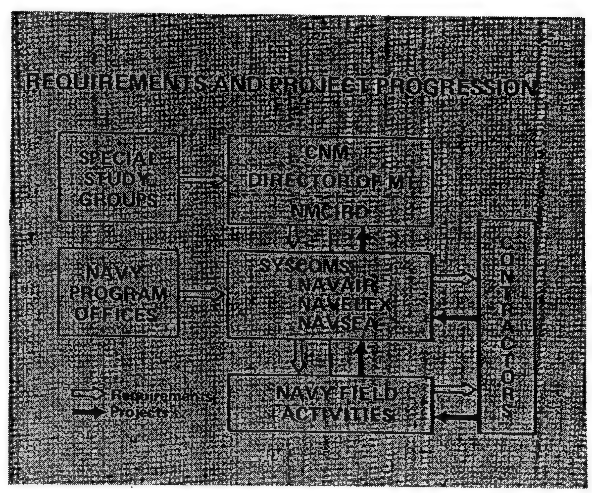


Figure 2

Program offices and special study groups are instrumental in generating technology requirements. Confirmed requirements are passed from the Chief of Naval Material to the Systems Commands for full verification and substantiation. Performing activities then define projects to answer those requirements—contractors play a very significant role in the program.

Review of project proposals is performed at several levels within the government. Navy coordination is conducted by NMCIRD and interservice coordination takes place through tri-service MTAG technical subcommittee meetings. Project approval and funding authority resides with the Program Director at Naval Material Command Headquarters in Washington.

The Navy has invested $57.0 million in its MT program, beginning with initial funding in FY 77. The potential return on investment of successful projects is estimated to be in excess of 6 to 1. However, this is based on a small sample size since only now are the FY 77 projects coming to fruition.

Two examples of successfully completed projects follow.

TORPEDO PROPELLER MANUFACTURE

A program was conducted to reduce the cost of manufacturing torpedo propellers by establishing production plastics molding techniques. In the past, propeller design specifications restricted manufacturing methods to machining. With the advent of the advanced MK46 (Neartip) torpedo propeller design incorporating various cost reduction features (fewer and thicker blades and blunter leading and trailing edges), it became feasible to investigate alternative manufacturing methods and materials to significantly reduce production costs. With the feasibility of molding plastic torpedo propellers having been established, an MT effort was launched in FY 78 to move the molding technique from the feasibility state to the production floor.

The cost of the MT effort, completed in April 1980, was $287,000. The cost of a set of machined Neartip torpedo propellers (two counter rotating) is $1500. The estimated cost of a molded set is only $360. Based on a procurement of 6300 Neartip torpedo propellers through FY 85, the estimated total savings are $7,182,000. This technology will be implemented on the next Neartip torpedo production contract.

GRAPHITE EPOXY SUBMARINE MAST

Submarine performance at periscope depth has traditionally been limited by performance characteristics of periscopes, antennas, and masts, which are extended for surveillance and communication. The majority of these masts have a circular cross section and produce excessive wake, vibration, and noise. Attempts to streamline them with retractable fiberglass fairings have met with limited success. Streamlining by different cross section design has been hampered by the designers' use of stainless steel and fiberglass. Insuring an adequate stress level in a mast made from these materials requires a large, bulky structure that negates the purpose of streamlining. In order to meet streamlining requirements, the **Dark Eyes** project is developing a titanium mast, which is both expensive and difficult to manufacture.

Therefore, it was proposed that the titanium be replaced with a composite material. Graphite epoxy is a high strength composite whose usage has advanced to the point at which more efficient production techniques are required. This material is extremely stiff and has a high strength to weight ratio, both highly desirable attributes in mast construction. Its use in this application offers large reductions in production costs. Considering these advantages, an MT project was initiated in FY 77 to develop manufacturing techniques for efficient, low cost fabrication of composite masts.

To date the cost of the MT effort is $403,000. It is estimated that the composite mast will cost only $28,000 compared to $70,000 for the titanium mast. Based on procurement of 42 masts through FY 86, the estimated total savings will be $1,760,000. This technology will be implemented on the next **Dark Eyes** contract.

Efforts Vital To Defense

If the Navy's forces are to be maintained at levels to sustain mission essential requirements, rather than what the Navy can afford, then Government and Industry must act together to best utilize available technology, capital and labor quality to attain those goals that best serve our country's defense needs. The manner in which the major elements are addressed—in particular, technological change—can strongly affect our defense posture through increased productivity.

The Navy Manufacturing Technology Program outlook is good and our experience thus far has been worthwhile. We look forward to improving our record and performance.

Mission Clearly Defined

Air Force Program Features "Top 10"

JAMES J. MATTICE is Director of the Air Force Manufacturing Technology Program managed out of the AFWAL Materials Laboratory, WPAFB, Ohio. Since assuming that position in 1974, he has been responsible for the planning, implementation and operating effectiveness of the technical, financial, and administrative management aspects of the AF Manufacturing Methods Program and the Computer Aided Manufacturing Program. Mr. Mattice received his B.S. in Chemistry from the University of Portland in 1958, did his graduate work in Chemistry at Ohio State University (1959-1962), and, under the AF Executive Development Program, attended Stanford University as a Sloan Fellow, completing that graduate program in Business Administration in 1968. He has served in several capacities at the Materials Laboratory, including service as Chief of the Chemical Processing Branch, Chief of Operations, and Assistant Chief of the Manufacturing Technology Division, prior to his present position. He has received numerous awards including the International Personnel Management Association and Dayton Area Chamber of Commerce Outstanding Supervisor of the Year Award in 1976, The AF Systems Command Certificate of Merit in 1978, and the Meritorious Civilian Service Award in 1979.

The ultimate goal of the Air Force ManTech Program is to achieve weapon systems' cost reductions in the acquisition, ownership, and support phases. A further goal is to provide for the maximum production efficiency of critical performance military hardware.

Major Accomplishments

All of these goals have been outstandingly achieved in the following "Top 10" Air Force MT Programs. The programs include the

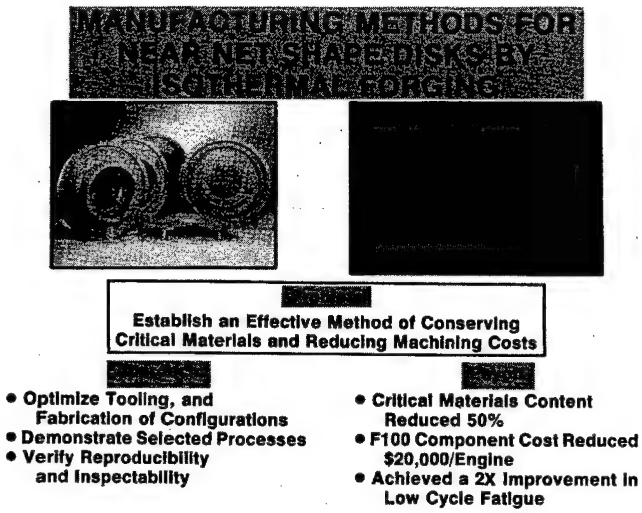
- Isothermal Forging of Near Net Shape Disks
- Automated Production of Hermetic Chip Carriers (HCC)
- Development of Quality Cast Aluminum Structural Components
- Fabrication of Zinc Sulfide FLIR Windows
- Hot Isostatic Pressing (HIP) Densification of Castings
- ICAM Robotic Sheet Metal Drilling and Routing
- Production of 30mm Armor Piercing Rounds
- Automated Fatigue Crack Inspection of Aircraft
- Engineering of Carbon-Carbon Nozzles for MX Missiles
- Modernization of F-16 Manufacturing Procedures.

Brief highlights of each of these programs follow.

ISOTHERMAL FORGING OF DISKS

The reduction of costs together with the conservation of critical materials were two key objectives in the development of manufacturing methods for near net shape disks by isothermal forging. Full laboratory qualification of the process via microstructural and mechanical property analyses was an additional goal.

These objectives were fully achieved with the development of a two step isothermal forging process capable of producing near net shaped configurations based on a 0.050 inch envelope over the finished part. The full scale parts forged were lighter than conventional one step forgings and responded well to heat treatment. The im-

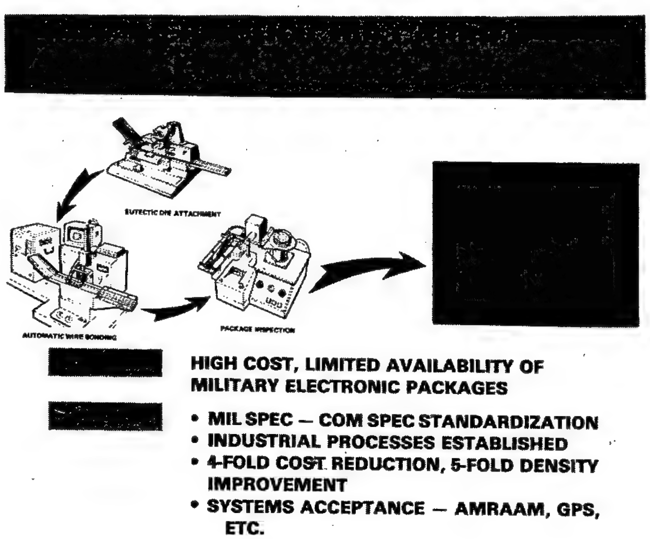


proved process resulted in mechanical properties significantly exceeding production specifications for the material.

A sonic inspection phase demonstrated the ability to fully inspect near net shape forgings through extension of state of the art transducer and pulser design. During this final phase a cost study revealed that $20,000 and 50 percent of the critical materials required were saved per F-100 engine upon complete incorporation of the two step isothermal forging process.

HERMETIC CHIP CARRIERS

The Hermetic Chip Carrier (HCC) is a low cost, high

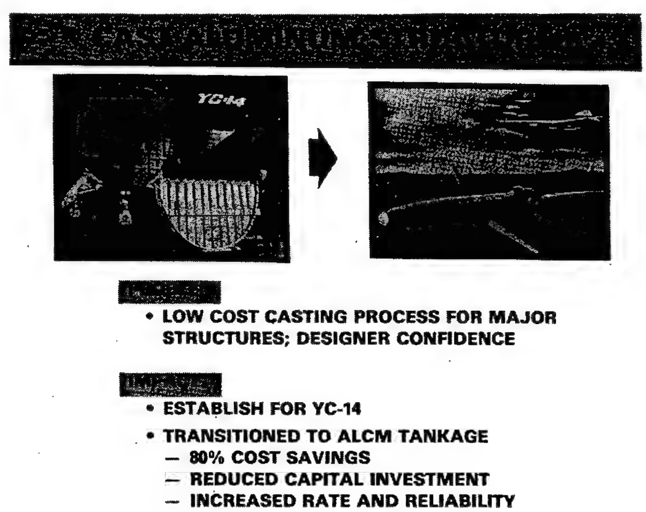


density microelectronic package used in the interconnection and protection of integrated circuit chips. HCC packages permit the integrated circuit chip to be automatically assembled and functionally tested in a hermetic sealed package prior to further integration or interconnection in an electronic system. Potential system applications include the advanced medium range air to air missile (AMRAAM), global positioning system (GPS), and the Navy AN/UYK-44 standard computer.

A major key to cost reduction was determined to be high packing density combined with automated assembly and automated full functional circuit testing. The leadless HCC eliminates the cost of leads, the gold on the leads, and handling problems associated with leads. The use of chip carriers further results in a lower systems cost because the high packing density obtained with chip carriers requires less board and cabinet space.

As an example of typical cost savings, a central processing unit (CPU) built with all small scale integrated circuit chips fabricated in present commercially available dual inline packages would cost approximately $8,000. By contrast, the cost of a similar CPU with more compact circuit structure fabricated in HCC packages is $2,000.

CAST ALUMINUM COMPONENTS



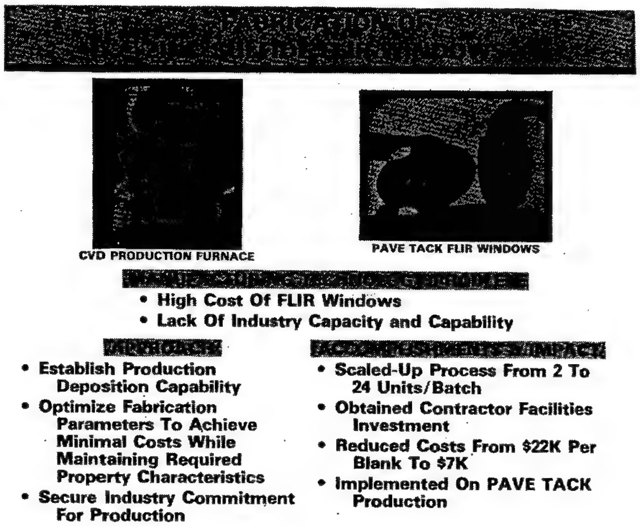
The cast aluminum structural components MT Program successfully demonstrated the integrity, producibility, and reliability of cast aluminum primary aircraft structures. The program was undertaken as a direct result of the escalating costs of conventional aircraft fabrication methods.

The Air Force YC-14 body/nose landing gear support bulkhead was used as the trial component because of its high cost, complex shape, large size and primary structure. Twenty bulkheads were successfully cast.

The cost of the cast bulkhead was 38 percent less than the sheet metal buildup fabrication. In addition, the unit satisfied all durability, damage tolerance, and static strength requirements.

The YC-14 casting technology was utilized further to develop a new cast fuel tank concept. Estimates are that the new cast tank concept will dramatically reduce costs of this unit by some 80 percent.

ZINC SULFIDE FLIR WINDOWS



An Air Force MM&T Program led to an increase in production capacity and cost reductions of large zinc sulfide windows for FLIR applications using the chemical vapor deposition process. Previously, only two windows per deposition run could be made. At the conclusion of the program, up to 24 window units could be fabricated per deposition run.

To achieve this success, a multiplate deposition system was designed and built. Also, process conditions for depositing the material were optimized, and quality control procedures were established.

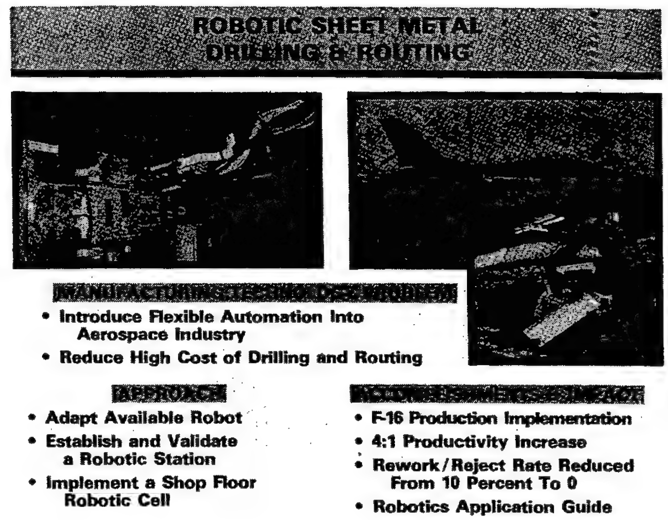
Currently, window blanks are being fabricated on a production basis for PAVE TACK at a rate consistent with the program schedule. The cost of the blank has been reduced from $22,000 to under $7,000.

HIP DENSIFICATION OF CASTINGS

As indicated by the previous example of cast aluminum components, one of the major initiatives of the MT Program is to improve the integrity of castings and expand the utilization of casting technology for complex aircraft and engine components. A new approach termed Hot Isostatic Pressing (HIP) densification provides closure of microporosity and segregation commonly found in cast components, thereby increasing their integrity.

The program has enabled production of HIP densified castings. Cast properties have been improved up to 80 percent over wrought properties. For example, over 200,000 cast turbine blades have thus far been produced using this method. The HIP densification process has been incorporated as a new industrial base capability. Annual savings are estimated to be in excess of $1.5 million.

ROBOTIC SHEET METAL DRILLING

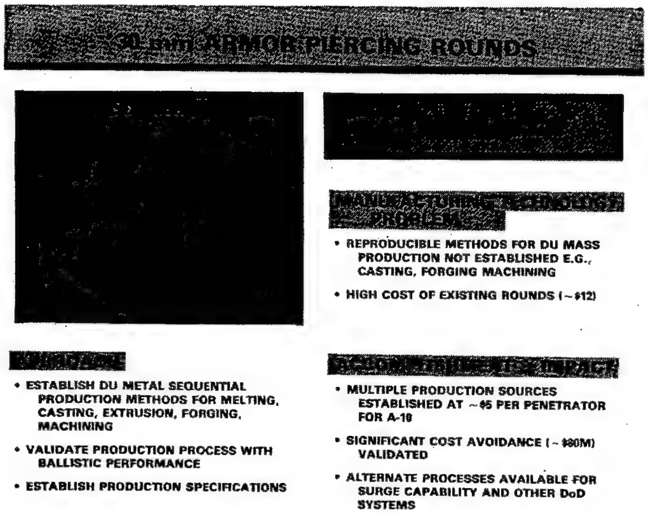


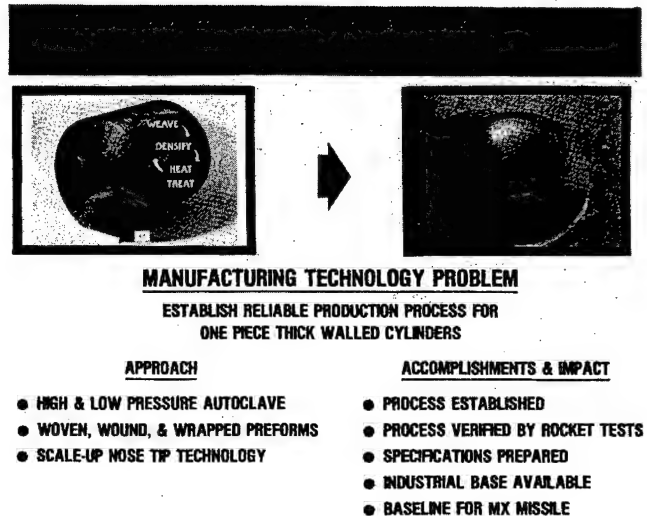
Under the ICAM Program, a robotic sheet metal drilling and routing cell has been successfully demonstrated on the F-16 production floor. In six months of operation, productivity has increased by 4:1 and perfectly worked parts have been the result. Six more robotic applications are being undertaken.

30mm ARMOR PIERCING ROUNDS

Depleted uranium (DU) plus ¾ weight percent titanium is used as a high density penetrator material to provide the armor piercing capability for the A-10 weapon systems. MT Program efforts established requirements for raw materials, methods for melting, casting, extrusion, swaging, forging, heat treating, and finishing. Material and process variables were correlated with ballistic performance to establish the most efficient and lowest cost methods to produce penetrators.

As a result, the U. S. capability to meet production requirements for DU plus ¾ weight percent titanium (now applicable to Army systems as well) was dramatically





advanced and cost avoidance for the Air Force alone is estimated at $80 million.

AUTOSCAN METAL FLAW DETECTION

Autoscan is a newly developed process for detecting fatigue cracks in metal. Ultrasonics, similar to the radar detection of aircraft except on a microscopic scale, penetrates metal and pinpoints flaws, cracks, and defects. Autoscan provides a quality analysis of fastener holes aided by microprocessor control and signal processing.

In aircraft, fatigue cracks start at weak spots caused by fastener holes. Autoscan utilizes a focused ultrasonics beam with a small spot size which precisely scans the edges of a fastener hole and inputs all information to the microprocessor.

Approximately 15,000 fastener holes per year are inspected. Using conventional methods, the cost is $125 per hole and one hole requires approximately two hours. With Autoscan, the rate is 60 holes per hour, and the technique does not require potentially damaging fastener removal. As a result, the aircraft spends much less time in the depot, and the flight safety margin is greatly enhanced through more reliable inspection.

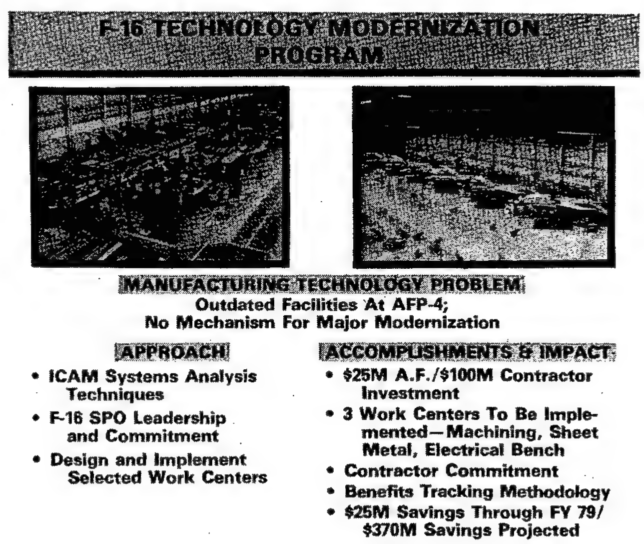
CARBON-CARBON MX NOZZLES

Carbon-carbon composites are the only materials that can withstand the 6500 degree F temperature and erosion conditions of MX rocket nozzles. Ballistic missile nose tips are made of this material, but are small compared to the billet sizes (400 pounds) needed for MX nozzles.

The manufacturing processes involved are high dollar value added steps applied to high dollar value preforms. Consequently, the rejection rate for billets must be low. The cyclic process requiring as many as seven cycles of densification and heat treatment is a major production cost.

A new MT Program high pressure process requires half the number of cycles as does the lowest pressure process. Excellent performance and erosion rates have been demonstrated. As there is no alternative to carbon-carbon nozzles, all propulsion stage contractors plan to use carbon-carbon one piece nozzles in the current MX full scale engineering development program.

F-16 MODERNIZATION



Production requirements for the F-16 have necessitated radical changes in production capability. Accordingly, the Air Force F-16 Systems Program Office (SPO) is investing $25 million to thoroughly evaluate the F-16 manufacturing capability.

The ICAM Program Office at the Materials Laboratory is managing all technical efforts for the SPO in this program. ICAM systems analysis expertise has been the driving factor in establishing the "top down" discipline required to investigate all facets of F-16 manufacturing and to identify the key cost drivers.

ICAM expertise in the application of computers to all aspects of F-16 manufacturing, as well as in modeling and simulation techniques, has established the direction for the design of work centers. Three work centers are being established to significantly improve production in machining, sheet metal fabrication, and electrical wire harness construction.

The F-16 contractor is investing $100 million to implement the new manufacturing procedures. A future savings of $350 million is projected from this process modernization effort.

Other Accomplishments

Additional significant Air Force MT Program accomplishments are as follows:

- Laser Drilling of Aircraft Engine Turbine Components
- ICAM Integration of Multiple Manufacturing Technologies
- Metal Fatigue in Aircraft Fasteners Decreased
- Computer Aided Ultrasonic Inspection Systems Integrated
- Computer Numerically Controlled (CNC) Contour Roll Forming
- ICAM Robotics/Sheet Metal Panels
- Integrated Blade Inspection System
- ICAM Program/Modules for Efficient Manufacturing Management and Operations
- Automated Assembly Fixture Drilling
- Production Process for F-16 Laminated Canopy
- Manufacturing Methods for Strategic Materials Reclamation
- Advanced Precision Machining

Incentives for Modernization

Calling for "innovative processes and approaches," the Air Force Aeronautical Systems Division (ASD) at Wright-Patterson Air Force Base announced in early June that future multiyear weapons contract awards will give incentives to contractors utilizing advanced manufacturing techniques such as those just described. The new policy, part of the division's overall MT Program, is a clear effort to cut costs and increase productivity among contractors. The policy serves as further proof of Air Force commitment to advanced manufacturing methods.

MT Objectives

Basically, there are three Air Force MT Program objectives:

(1) Establish manufacturing processes and validate them in a production environment.

(2) Establish a basis for the systems approach to manufacturing, including the integrated demonstration of computer based activities.

(3) Support production/manufacturing management activities throughout the acquisition life cycle.

It is intended that these goals satisfy the DoD and National needs and concur with an Air Force business strategy which seeks to incentivize greater industry involvement in MT transition and implementation.

To meet criteria for initiation, MT Programs for the Air Force must

- Provide solutions to broad based production problems.
- Establish a demonstrated production capability.
- Provide a needed manufacturing process which would not otherwise be available.
- Establish manufacturing processes which are beyond the normal risk of industry.
- Provide a tangible, worthwhile benefit or ROI.
- Be strongly linked to specific systems to be acquired.
- Have direct application to Air Force Depot needs.

These criteria, as influenced by the criticality of needs, are utilized by the Air Force in formulation, prioritization, and implementation of all MT Programs. The program requirements and budget requests are processed through various AF command levels. As an integral part of the MT Program operation and responsibility, close coordination and liaison is maintained with MT user organizations within the AFSC Acquisition Divisions, AFLC Logistics Centers, other Air Force laboratories, and industry.

MT Program Approach

The Manufacturing Technology Program provides the Air Force with the required advanced manufacturing technology to assure the producibility of future Air Force weapon systems and to establish the lowest cost methods for their manufacture, maintenance and retrofit. The MT Program is a vital mechanism for translating proven research and development advances into validated,

economic, certified production practices. It provides manufacturing processes and techniques in advance of acquisition requirements to

- Insure timely availability of materials, components, structures and devices.
- Alter outdated fabrication methods.
- Improve equipment and material utilization.
- Provide for alternate sources of critical/strategic materials and commodities.
- Reduce direct labor and labor associated overhead costs.

The Air Force MT Program encompasses a wide range of disciplines including manufacturing methods and production feasibility in the areas of metals, nonmetals, composites, and electronics and the development of computer integrated manufacturing procedures. One of the specific goals is the consideration of indirect as well as direct costs traditionally associated with manufacturing.

Definite Guidelines Established

All MT projects are conducted under contracts with private industry through competitive procurements. The contracts are negotiated with an Air Force business strategy aimed at securing all data rights, establishing commitments for competitive production sources and requiring end of contract briefings and demonstrations on contract results. These contractor briefings to government and industry competitors alike are a key factor in the transition of new or improved manufacturing technology to and within that industry segment.

The importance of early implementation of the newly evolved MT is being stressed through a tie-in with technology modernization initiatives—and by using implementation/technology transfer plans as a key factor in source selection. Technology transition is also achieved through technical workshops, seminars and disciplinary studies, in association with Industry and other Government agencies.

In summary, the MT Program

(1) Establishes new manufacturing methods and production procedures

(2) Implements technology transfer

(3) Stimulates the implementation of results and industry investment

(4) Directly supports small business and basic industry manufacturing efforts

(5) Builds on prior R&D results and demonstrations

(6) Impacts system acquisition and logistics areas where high ROI is possible.

The MT Program does not provide for

(1) Funding of capital equipment and facilities

(2) Conduction of R&D programs

(3) Support of proprietary developments.

Although the MT Program does initiate projects for new or improved manufacturing methods, a major effort is devoted to manufacturing cost reduction and production economics. The various individual MT Projects are justified and evaluated utilizing the following merit rating method:

RATING = (ROI) x (GENERIC RELEVANCE) x (PROBABILITY OF SUCCESS) x (PROBABILITY OF INCORPORATION)

The ROI factor is the ratio of the Real Production Cost Savings to the MT Program Investment.

Funding

The MT Program budget request is submitted to the Congress for review and approval as a P.E. 7.8011F line item. The approved FY-81 budget and proposed FY-82 funding are presented in Table I. The funding is divided into major application area categories which represent "focal point" planning areas within AFML. The Air Force MT Program budget has increased significantly in the past 7 years (i.e. from $12 million in FY-73 to $56.7 million in FY-80) due to the increased emphasis in acquisition and maintenance cost reduction, and technology utilization.

Attempts are being made to establish the use of 08M (3400) funds to better support AFLC needs and the use of 3600 funds to initiate a manufacturing R&D program.

MT Category	FY-81 Budget ($K)	FY-82 Proposed
Thermal Protection	0	0
Metal Structures	5,653	7,319
Composite Structures	3,200	6,250
NDE/QC	4,147	5,950
Propulsion	15,511	17,201
Fluids, Lubricants And Containment	0	750
Protective Coatings	0	400
Electronics	18,971	14,900
Hardened Structures	527	1,112
Munitions	3,238	3,977
Computer Integrated Manufacturing	18,600	19,900
TOTAL	69,847	77,759

Table 1

The Department of Commerce and Productivity

Highest Priorities Set

The Secretary of Commerce has identified the two highest priorities for the Department as international trade and productivity. To pursue these priorities, with the approval of President Carter, Secretary Klutznick in February of 1980 called for the establishment of the Office of Productivity, Technology, and Innovation (OPTI). This change set the organizational structure the Department will utilize to assume a major role in improving U. S. productivity performance.

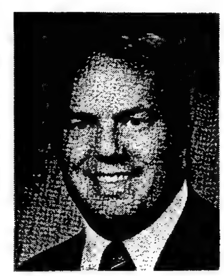
Headed by Assistant Secretary Jordan J. Baruch, OPTI absorbed the Office of Science and Technology that includes the National Bureau of Standards, the Patent and Trademark Office, and the National Technical Information Service. Beyond these efforts, however, OPTI has the primary responsibility for implementing the industrial innovation initiatives announced by the President in late 1979.

Technology Most Important Influence

The goal of OPTI is to increase the competitive position of U. S. industry. Improving productivity is one of the most effective means of achieving that goal. To improve productivity, the major emphasis will be on technology, which many agree is the most important influence on productivity. The primary target for this emphasis will be the private sector. The efforts of the Department should not be to supplant private sector efforts, but to play a supportive role in creating a climate to encourage industrial activities.

The strategy to achieve OPTI's goal will be threefold:

(1) To assist industry in improving productivity through the application of technology, science, and innovation

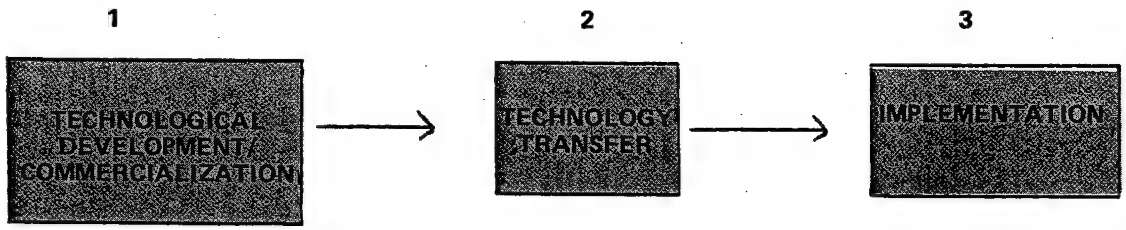


MR. CHARLES KIMZEY is Assistant Director, Cooperative Generic Technology Program, Office of Assistant Secretary of Commerce for Productivity, Technology and Innovation. Mr. Kimzey has been involved in the productivity field for over six years. His experience in productivity goes back to some of the earliest efforts of the Government to deal with the productivity issue. He was with the National Commission on Productivity and Work Quality chaired by Vice President Rockefeller. Mr. Kimzey was Director of the Capital and Technology Program for the Commission's successor agency, the National Center for Productivity and Quality of Working Life. His responsibilities in that capacity included the development of national policy recommendations to stimulate technology innovations as a means of improving U. S. productivity performance. He organized and conducted a Government/industry/labor delegation to examine the status of Japanese technology and manufacturing. He has private sector experience in his own retailing and service firm. He also organized and is currently a Director and Chairman of the Strategic Planning Committee of the Continental Bank and Trust Company of Springfield, Virginia. Mr. Kimzey has a Bachelor of Science degree from the University of Maryland and a Master of Business Administration degree from American University.

(2) To develop policies and programs to lower the barriers to productivity improvement

(3) To assist foreign buyers in purchasing U. S. goods and services.

For discussion purposes (risking great oversimplification), we can collapse the technological innovation process—for either product or process—into the following model:



To impact national performance, implementation of technology by industry must take place. Great research and technology, if it doesn't find its way onto the plant floor, will be ineffective in achieving productivity and trade balance improvements. One way of attacking improved implementation is to effect improvements in the first two areas above. With this in mind, OPTI's programs are being developed to build in a "demand-pull" element on both the first two processes. This means that industry input will be sought to establish priorities (demand) for projects in technical development and transfer. An interest (or "market") should be evidenced by industry for these activities. To simulate ultimate implementation, OPTI's plans include both efforts to encourage the pace of technology development and to improve the transfer of technology.

Technological Development

Assistant Secretary Baruch has described one of the most important of OPTI's programs related to technological leadership and trade competitiveness. It is the Cooperative Generic Technology (COGENT) Program. This program will explore within the U. S. free enterprise system a principle the Japanese and the Germans have utilized very effectively—the principle of cooperation—industrial firms with one another and in turn with government. COGENT is an attempt to reduce the adversarial government/industry relationship as a means of accomplishing national goals. The specific objective of the program is to stimulate development and use of technology having application and usefulness in several industrial sectors. The target is generic technology which is downstream on the innovation spectrum from basic research, but considerably upstream from product development.

The principal advantages for a firm to participate in the program would be a leveraging of resources to accomplish tasks that are too large, too long term, or too risky for a single firm. This leveraging would be both financial and intellectual. Individual firms would pool their funds with the government to attack problems identified by industry. Firms participating would be afforded the opportunity to be involved with other firms in the process of identifying common problems and alternative solutions, as well as actively involved in achieving those solutions.

Nonprofit Corporation the Vehicle

The mechanism for cooperation is the Cooperative Generic Technology (COGENT) Center. The Center is planned to be a nonprofit corporation established by the private sector. Firms participating in the Center would elect their own Board of Directors. This private sector Board would allocate the resources of the Center.

The financial resources of the Center would come from both government and industry. COGENT will provide seed money to establish the Center, with support declining to 20% or less in the fifth year of operation. The industry contribution is considered a necessary ingredient for a Center as evidence of commitment to its success.

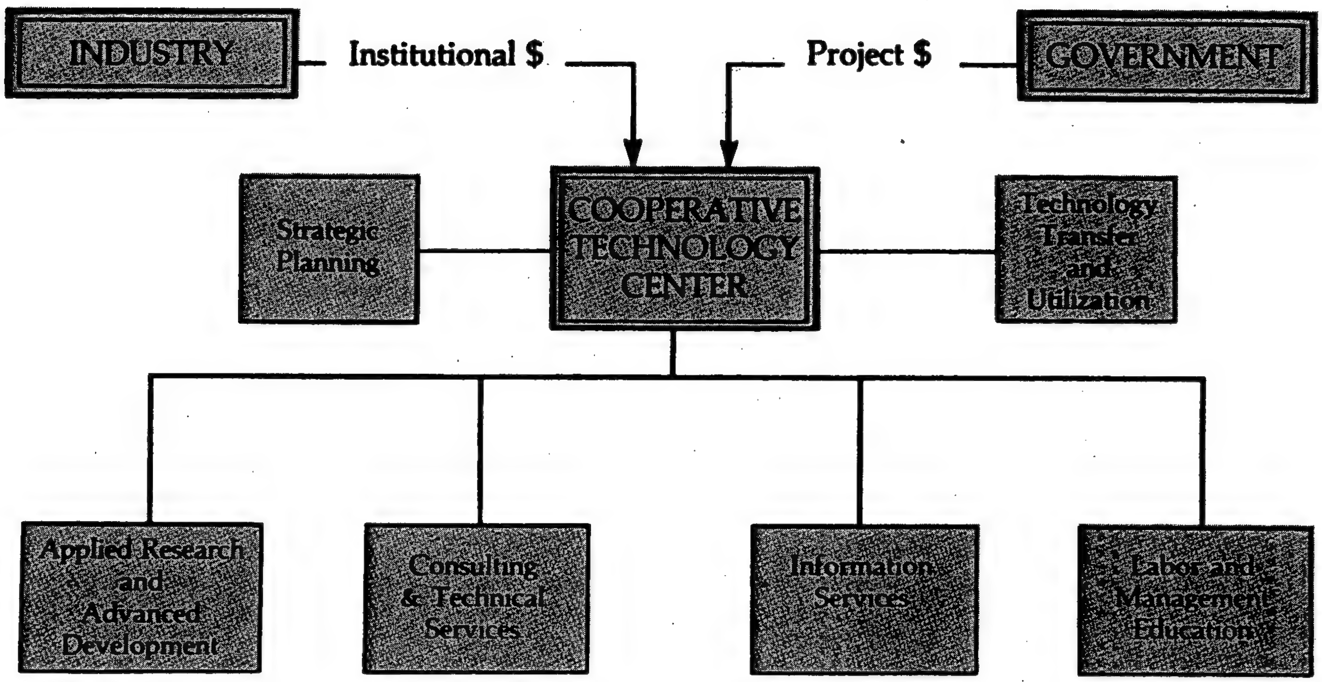
The activities of the Center are anticipated to include both technology development and transfer efforts. The joint research projects would be complemented by an information clearinghouse, technical services, and educational programs to train management and labor in the application of the technology produced.

Technical areas that are being explored for possible COGENT Centers include tribology (the science of friction and wear), computer integrated manufacture, welding, surface technology, and powder metallurgy. Studies seeking broad industry input performed by the staff of the COGENT Program have also supported the importance of these areas to the improvement of international competitiveness.

The COGENT Program is planned for fiscal year 1981 with funding currently indicated at $5.2 million. Public comment was solicited on the procedures for the program in June and July, 1980. The final COGENT Program procedures, taking comments received into account, were published in the Federal Register on August 14, 1980.

Commercialization

The process of commercializing a new product can cost between ten and one hundred times the amount spent for research to develop that product. These are painful facts, particularly to small business. OPTI intends to establish two Corporations for Innovation Development (CIDs) in FY 81 to address this problem. CIDs will provide direct



equity funding for the startup of firms wishing to develop and bring to market a promising, high risk innovation. CIDs will also provide assistance to potential applicants in obtaining second round financing and early management assistance to the firms funded.

One CID will be established in an industrial region, the other in a region less industrialized. A revolving loan fund provided by the Department of Commerce's Economic Development Administration will be established, with states expected to provide matching funds.

The CID program is being partly modeled after the successful British National Research and Development Corporation and existing state organizations such as the Connecticut Product Development Corporation.

Technology Transfer

The Federal government spent nearly $10 billion for research in 1978. The Center for the Utilization of Federal Technology (CUFT) is planned for FY 81 to generate a greater and more rapid return for the nation on the investment of Federal dollars in R&D. CUFT, to be housed at the National Technical Information Service (NTIS), will seek to increase the utilization by industry of federally developed technical information through intensive marketing including conferences, forums, and special services. CUFT will assemble and maintain a centralized information system on technology, will act as licensing agent for Federal patents, and will promote the interchange of professional staff between Federal laboratories and the private sector. CUFT will be the organization that industry can turn to when seeking information about federally developed technology. One very important element of CUFT will be development of a CUFT Technology Fellowship Program in which representatives of the private sector will be sponsored by their firms to spend equal time in Federal laboratories and in the private sector to assess potential yield of Federal technology to industry.

Domestic, Foreign Data Available

The Productivity Reference Service (PRS) is also planned for FY 81 to become the primary source of information in the Federal government on the subject of private sector productivity improvement. PRS will provide national and international information on such areas as capital, managerial know-how, and human resources. The PRS will focus on building the productivity information clearinghouse, which will include identifying and describing productivity success stories in the form of case studies and seminars.

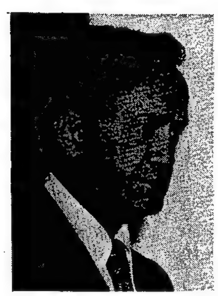
A third initiative aimed at improving the transfer of technology planned for FY 81 is the Foreign Technology Utilization Program. This program, as part of the NTIS, will provide better access to foreign developments by collecting, translating, and disseminating selected scientific and technical information produced by other nations.

There is significant opportunity for the Department of Commerce/Office of Productivity, Technology and Innovation to learn from the long history of the Department of Defense in developing and encouraging implementation of new technology. Much of the work ManTech is supporting is directly related to the areas COGENT is exploring. As these program plans evolve, we are looking forward to identifying the ways and means our efforts can complement the Department of Defense as the common goal of productivity improvement is sought.

MTAG Coordinates Overall MT Effort

Steadily Moving Ahead

CHARLES P. DOWNER is Director of the Defense Industrial Research Support Office of the Deputy Under Secretary of Defense, Research and Engineering. He also serves as the Senior Staff Specialist for the Department of Defense Manufacturing Technology Program. Mr. Downer served for 25 years in the United States Air Force, where he specialized in production and procurement, industrial resources management, and manufacturing technology. Mr. Downer holds a B.S. degree from Mississippi State University.



Technology advances in manufacturing processes are a major goal of the Department of Defense. Although aimed at defense systems, technology improvements in the DoD manufacturing process normally have much wider application and can benefit civilian production as well. Such improvements are constantly emerging from DoD's Manufacturing Technology (MT) program.

For example, the manufacture and use of numerically controlled machine tools is a worldwide industry with far reaching implications across a broad segment of manufacturing and production processes. These tools are widely recognized as a vital part of modern mass production technology. First developed under an Air Force program to produce high performance military aircraft, they are just one of many spinoffs of the MT program.

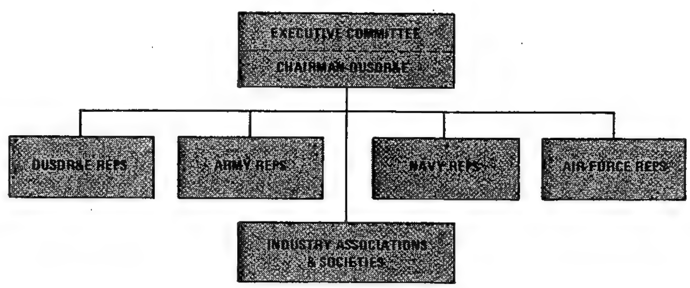
This MT effort is designed to develop or improve manufacturing techniques, processes, materials, and equipment in order to provide timely, reliable, and economical production of defense materiel. The program is proving to be not only a boon to military procurement budgets but important to the nation's entire economy.

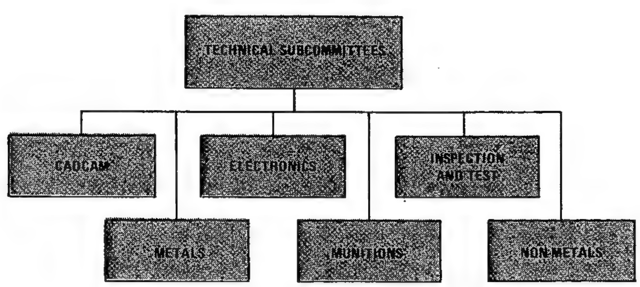
Service Interaction the Key

A key factor in the success of the MT program is close coordination and cooperation in program efforts between the services. Each service has a central MT office responsible for identifying, funding, and managing a servicewide program that addresses high cost manufacturing problems. To coordinate these efforts, DoD established the Manufacturing Technology Advisory Group (MTAG) composed of an executive committee and six technical subcommittees. This group reviews the planning implementation programs, and accomplishments of each MT office to identify duplication of effort, potential joint efforts, and technological voids in the overall MT effort.

Key elements in MTAG's mission are to

- Improve the responsiveness and efficiency of the U. S. production base by promoting technology diffusion and broad implementation of innovative manufacturing technology among the military services, industry, and other government agencies.
- Encourage the use of standard documentation formats among the services in their MT programs.
- Promote the reduction of weapon system costs and production lead times by encouraging the use of advanced technologies in U. S. industry.





Executive Committee Spawns Subcommittees

The MTAG Executive Committee includes two representatives of the Office of the Under Secretary of Defense Research and Engineering, one of whom is chairman, and two representatives from each military service. Meeting no less than four times a year,

this committee provides broad policy guidance and translates policy guidelines into specific goals and objectives. Their purpose is to promote integration of Army, Navy, and Air Force programs into a coherent, DoD wide MT program.

The Technical Subcommittees cover six subject areas: Metals, Nonmetals, Electronics, Computer Aided Design and Manufacture, Munitions, and Inspection and Test. Each subcommittee meets at least three times a year. Subcommittee members are nominated by the military service members of the Executive Committee. The subcommittees provide technical analysis, joint planning, and coordination on MT projects in their subject areas; identify areas of concern and possible duplication; and propose courses of action to alleviate inefficient manufacturing processes. Consider a few of the results of DoD's coordinated MT effort.

ICAM Program Far Reaching

An example of a large scale, long range MT program is Integrated Computer Aided Manufacturing (ICAM), an effort of broad national interest and increasing prominence. ICAM is a seven year, $100 million effort intended to increase manufacturing productivity and to lower defense systems costs through greater use of computers and computer technology in the aerospace industry. Although many individual elements of computer aided manufacturing—design, process control, production scheduling, material handling, and management information, for example—have been applied in industry, they have not been thoroughly integrated in a single system. The potential payoff of doing this is tremendous. Typical returns on investment for implementation of individual elements have been 30 to 50 percent. DoD believes that the integrated systems being developed under the ICAM program offer even greater potential for increasing manufacturing productivity and return on investment. It is expected that this DoD sponsored program, properly coordinated with industry and other government agencies, will act as a catalyst to focus national attention and action toward more rapid development and application of this emerging technology.

Net Shape Fabrication

Because of basic shortcomings in conventional forging processes, U. S. manufacturers spend more than $100 billion annually removing metal from parts where it is not needed. In the fabrication of many conventional forgings, as much as 90 percent of the starting material ends up as worthless chips. Through various MT efforts coordinated by MTAG, processes are being developed to fabricate parts to very near "net shape", so that little or no machining is required. In other words, we are learning to put metal where it is wanted in the first place rather than devoting energy to removing it from places where it is not wanted.

For example, the Air Force was primarily responsible for the development of diffusion bonding, which uses plate stock to produce near net shape parts. In diffusion bonding, two or more metal parts form a molecular bond under pressure. The parts are cut to near net shape, stacked as a sandwich similar to plywood, and subjected to a small pressure (much less than that needed for forging), thereby permitting the use of a smaller press.

Diffusion bonding is especially valuable for metals such as titanium and superalloys. It not only reduces metal removal costs, but also conserves critically short, expensive strategic materials. Much of the development work was applied to the B-1 bomber, whose design included more than 100 diffusion bonded parts; a few are illustrated in Figure 1. Although this aircraft did not reach production, the MT programs on diffusion bonding developed important processing techniques with wide applications for the manufacture of other products.

Casting Slashes Costs

Another MT project that has shown a very good return on investment involves a new process to manufacture a special "tank killer" armor penetrator made of depleted

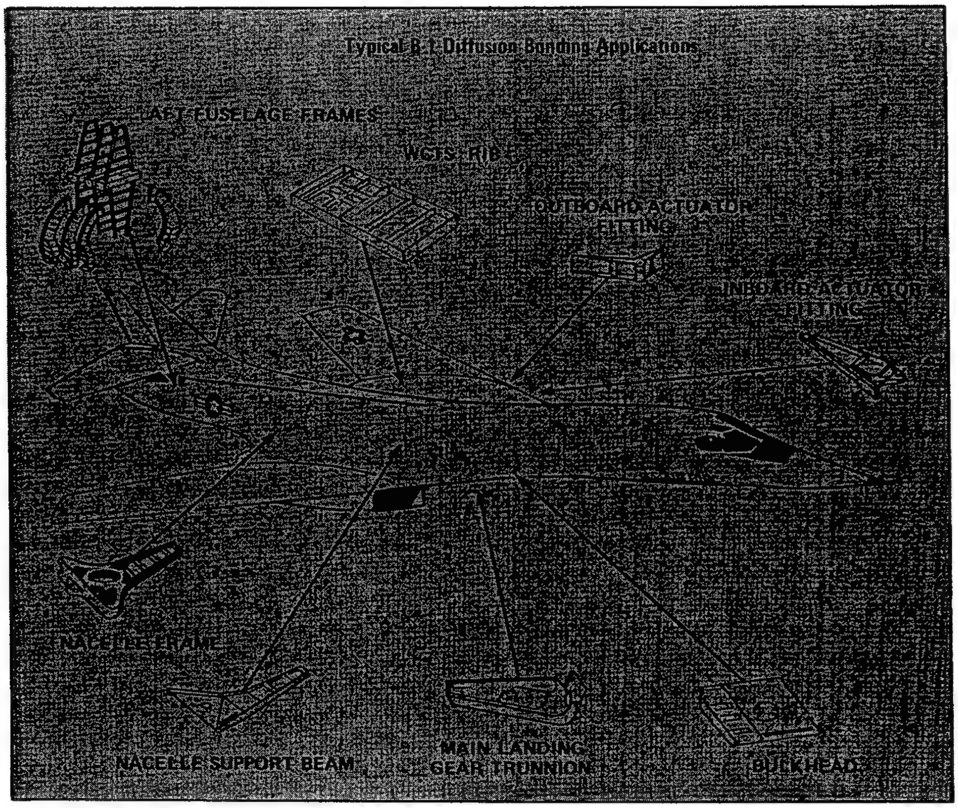


Figure 1

uranium. Development of this projectile was jointly sponsored by the Army and the Air Force for use in the GAU-8 gun. Originally, these penetrators were machined to the desired shape at a cost of $20 per unit. Then a new forging and swaging process was developed that reduced the cost to $8 per unit. Finally, cast penetrators were developed that reduce fabrication cost to an estimated $4 per unit.

These are just a few examples of the many successful MT programs that have been enhanced by MTAG coordination. Let's consider briefly the total scope of this program.

MT Concept

Begun in the early 1950's in the Air Force, DoD's MT program was given greatly increased emphasis in the early 1970's. DoD's appreciation of the program's contribution to reducing weapon systems manufacturing costs was recently summarized in a "Statement of Principles". The objectives of the program as outlined in the SOP are to

- Aid in insuring the economical production of qualitatively superior weapon systems on a timely basis.
- Insure that advanced manufacturing processes, techniques, and equipment are used to reduce DoD materiel acquisition costs.
- Continuously advance manufacturing technology to bridge the gap from R&D advances to full scale production.

- Foster greater use of computer technology in all elements of manufacturing.
- Assure that more effective industrial innovation is stimulated by reducing the cost and risk of advancing and applying new and improved manufacturing technology.

Geared To Cost Reduction

The primary purpose of this reemphasized and reoriented MT program is to reduce the manufacturing and life cycle costs of defense materiel. We all know that weapon systems costs continue to increase significantly, while the real dollars available for procurement diminish alarmingly. Defense procurement managers are constantly confronted with the need to reduce budgets and at the same time maintain or increase production. In view of this, weapon systems costs must be reduced if the United States is to maintain an adequate defense posture. Since manufacturing represents a major portion of these costs, the emphasis is placed on manufacturing cost reductions. The MT program is a primary approach to driving those costs down.

Broader Benefits

As already suggested, the potential benefits of the MT program go far beyond Department of Defense budgets. To see this, we only need to realize that manufacturing represents 30 percent of the gross national product—the largest single segment—and that DoD represents the largest single buyer of goods and services in the nation. Thus, reduction in DoD manufacturing costs will significantly impact a very large segment of the national economy and improve the competitive position of the United States in the world market place.

The development of numerically controlled tooling referred to at the start of this article is a classic example of what can happen with a large scale MT program. While it is not possible to accurately calculate the savings resulting from the original MT investment in that effort, it is safe to place it in billions of dollars.

Program Approach

The MT program is not an R&D effort. Rather, it is structured to bridge the gap between emerging R&D advances and full scale production. Projects are funded only after concept feasibility has been demonstrated. Currently, DoD is spending approximately $12 billion each year on R&D. An important goal of the MT program is to ensure that more of the results of this R&D investment are translated into fielded weapon systems.

The MT program provides proven options for the systems designer. A designer will not risk a new program by adopting new manufacturing methods or materials that are only laboratory curiosities. He wants proven manufacturing methods that are both production and service tested. With the proven options developed through MT efforts, productivity can be designed in and manufacturing costs can be reduced.

Potential benefits of manufacturing technology projects are threefold:

- Improved responsiveness of the industrial base
- Reduced systems costs
- Reduced dependence on foreign sources for strategic and critical materials by the development of domestically available substitutes.

For example, platinum cobalt for manufacture of traveling wave tubes used in electronic countermeasure equipment was once imported from the USSR. Then the Air Force produced a domestic material substitute through an MT project. The substitute

not only reduced cost and lead times, but increased the frequency range of the tubes, resulting in greatly improved ECM capability.

The 600 or so MT projects in operation at any one time encompass nearly all facets of DoD procurement and production. Typical examples of MT programs include the development of new welding techniques for tanks, advanced graphite and boron composites for missile and aircraft application, radiation hardened electronics, laser gyros, fiber optics, powder metallurgy forgings, and automated frame benders for ship beams.

Program Operation

Most DoD MT funds are placed on contract with industry as seed money to assist in establishing innovative production know-how. Such government assistance not only helps to lower defense systems costs, but also assists in the diffusion and application of new manufacturing technology throughout industry.

The results of MT projects are widely disseminated using several unique techniques. For example, each manufacturing technology contractor must perform an end of contract, full scale production process demonstration in his facility with industry competitors present. These demonstrations are particularly valuable since the majority of MT projects address generic manufacturing problems and the results have broad application.

Industry Cooperation

An important part of the MT program is close cooperation with industry. In addition to coordinating interservice programs, MTAG also seeks to engender greater service/industry coordination. Each year, MTAG conducts a coordination conference that serves as a means of technology transfer and diffusion. Industry is playing an increasingly important role in these meetings, which bring together their representatives and those of government agencies to stimulate awareness of proven manufacturing techniques and improve national productivity. Thus, every effort is being made to communicate manufacturing technology and avoid duplication of effort.

Realizing the urgent need to increase manufacturing productivity, industry has also endeavored to work closely with the manufacturing technology offices of each service to help reduce manufacturing costs. Representatives of industry actively participate in the structured process of identifying problems and establishing priorities for investment opportunities. Also, several industry associations participate in MTAG review and coordination of the entire program.

In cooperation with industry, the military services have held several "market analysis" seminars that resulted in detailed manufacturing cost analyses of major weapon systems. Subjects have included aircraft structures, composites, electronics, missiles, and tracked combat vehicles. Through such analyses, manufacturing problems and high cost elements in every major assembly, subassembly, component, and part of each major system have been identified. After identification of the cost drivers and manufacturing bottlenecks, manufacturing technology projects have been developed and prioritized to those areas of greatest need and greatest payoff.

MTAG Producing the Goods

In summary, the capability to produce cost effective, qualitatively superior weapon systems on a timely basis is significantly affected by the availability of advanced manufacturing technology. The DoD MT program, carefully coordinated by MTAG, has demonstrated that it can provide that technology. In a report released to Congress, the Comptroller General of the United States recently stated, "GAO believes that in order to remain internationally competitive and to maintain a strong industrial base, actions must be initiated to make manufacturing productivity a national priority." This is what the MT program is all about.

A Look At Electronics in 5-10 Years

CAD/CAM Subcommittee Pushes ECAM

Frederick Michel, Chairman

The CAD/CAM Subcommittee again had an active year. It currently has 40 members representing the three services, a DoD function, two other government departments, and five industry associations.

One of the more active groups was the ECAM (Electronics Computer Assisted Manufacturing) Ad Hoc Group chaired by Fred Michel. The ECAM project was recommended by the Electronics Industry Association at MTAG '78. The group is initiating the first steps in planning and executing a computer integrated electronics manufacturing program for DoD. It has the objective to develop a top down view or architecture of the techniques, processes, and management controls used in the design and manufacture of military electronic equipment and to identify the opportunities for automation and computer integration.

Upgrading Quality, Downgrading Cost

Interest in CAD/CAM electronics has been motivated by an awareness that approximately 33 percent of the cost of aircraft and 60 percent of the cost of missiles is for electronic components. This percentage is increasing because of increased performance requirements and the complexity of future systems.

Hybrid circuits are the third ranking cost driver in electronic circuits. The absolute cost of hybrids is also rising, as is their relative cost when compared to other DoD electronic components because of the lack of a need for hybrid circuits in the commercial marketplace.

Specifically, the Group's objectives are

- To study the feasibility of a tri-service electronics wedge
- To develop a tri-service electronics wedge promoted by both the CAD/CAM and Electronics Subcommittees of MTAG.

Representatives of the CAD/CAM and Electronics Subcommittees met in July 1979, summary letters of that meeting were written to the MTAG Executive Committee, and representatives of the Group met in January 1980 at Wright-Patterson Air Force Base to write a charter and discuss specific plans. Group representatives are currently identifying specific areas and relative tasks that can be applied to the whole project.

Opportunities for Automation

The CAD/CAM Electronics Ad Hoc Group works closely with the CAD/CAM Subcommittee. The Ad Hoc Group was established to interface with industry associations and with the CAD/CAM Subcommittee. It intends to develop a contacts effort with industry to augment the use of computer aided design and computer aided manufacturing in the production of electronic circuits and equipment. Like the MTAG Electronics Subcommittee, it will study the development of techniques, processes, and management techniques necessary for the design and manufacture of highly sophisticated electronic equipment.

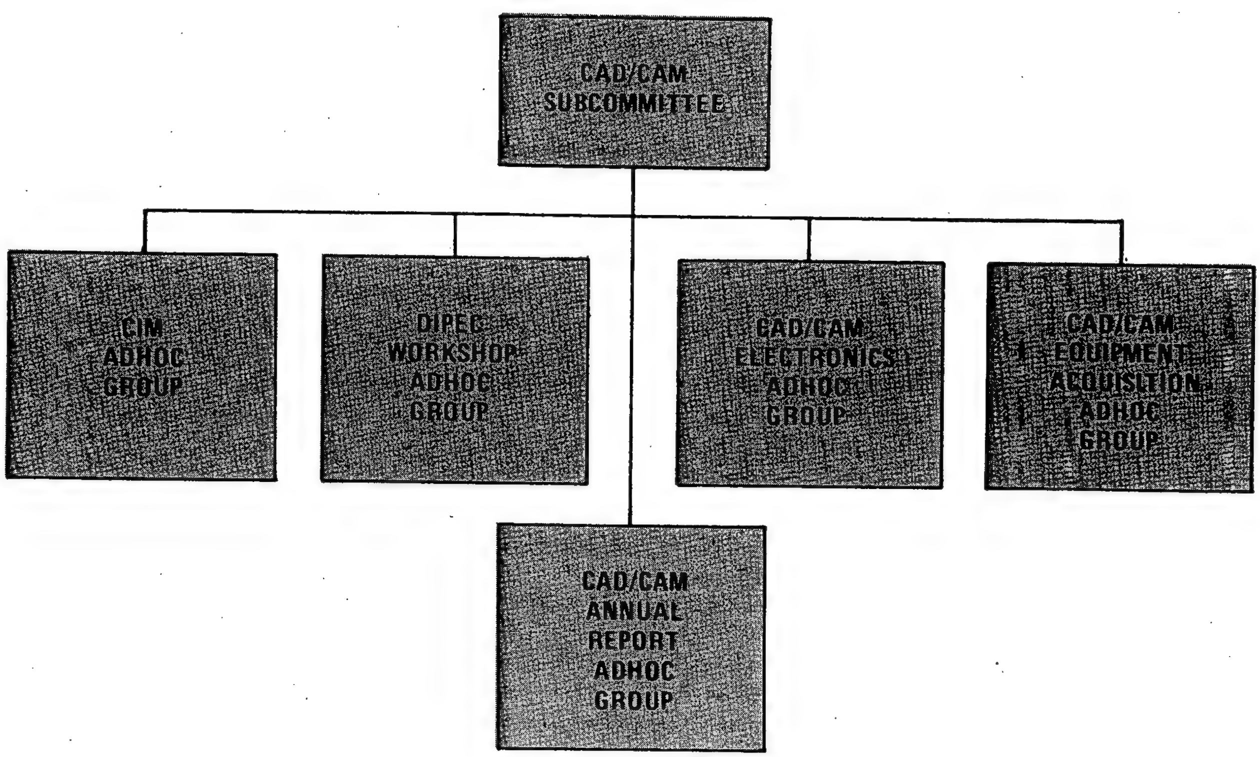
Thus far, the Group has identified a top down view or architecture as its first priority of action. A U. S. Army MICOM representative has been designated project manager for a contract to develop the first stage of this technology. In the near future, it is anticipated that Air Force and Navy representatives will be brought into the program as participants in the basic contract or to pursue specific designated areas.

Chairmanship Transferred

The full committee held two meetings—one on April 30, May 1 at Hartford, CN. At that meeting, the members discussed the FY 81 CAD/CAM programs of the three services, established Ad Hoc committees and discussed ongoing and potential tri-service projects. The transfer of the chairmanship from Dennis E. Wisnosky to Frederick J. Michel was one of the major events. Dennis has taken a job with International Harvester, where he hopes to apply the good things he has been instrumental in developing with the Air Force ICAM program. We all wish him the best of luck.

The other meeting was held on August 14 and 15 at St. Louis, MO. The discussions at this meeting centered around the Ad Hoc group activities, the ICAM Architecture, the DIPEC/NC Workshop, and MTAG '80.

CAD/CAM SUBCOMMITTEE



Electronics Subcommittee Features Generic Organization

Charles E. McBurney, Chairman

The major accomplishment of the Electronics Subcommittee is the effective coordination of the three services' MT programs in electronics and optics. As a result of continuing coordination efforts by program managers and engineers, a number of projects have been dropped or deferred and a larger number have been or are being run jointly to conserve funds.

The Electronics Subcommittee serves as a forum for exchange of technical information and ideas and stimulates the use of advanced technology in new areas. It deals with the many processes used to produce electronic and optical products; these are so varied that the group concentrates mostly on technologies that are common among the services. In this way, the Subcommittee can influence the individual service's programs in a constructive manner.

Proven to be A Dynamic Force

Several Subcommittee activities are used in the exchange of information and promotion of effective use of MT funds.

- Proposed projects are coordinated by Subcommittee members to eliminate potential duplication.
- Workshops and conferences are sponsored to create dialogue between DoD, industry, and academia concerning program direction and future projects.
- Program data is presented at the Annual Meeting to stimulate discussion concerning trends occurring in the service's programs.

Subcommittee activities for the year are set during the annual coordination meeting of the full Subcommittee membership. There, each service's budget and five year plans are reviewed; common areas of interest are identified and coordination actions are recommended to the services. After the actions have taken place, the results are documented in the Electronics Subcommittee Annual Report, which is available to both government and industry.

The Subcommittee has shown itself to be a dynamic force. During its six years of operation, it has been responsible for eliminating a number of projects that would have duplicated previous work, encouraged several joint service projects, and hosted a number of workshops and conferences. The results of these activities reflect the effective support of the Subcommittee members.

Six Technical Working Groups Utilized

The activities of the Electronics Subcommittee are carried out through six technical Working Groups in addition to those performed by the full Subcommittee. Technical Working Groups establish rapport with industry associations having parallel interests. The **Hybrids Circuit Working Group**, for example, holds its annual planning conference immediately before or after the

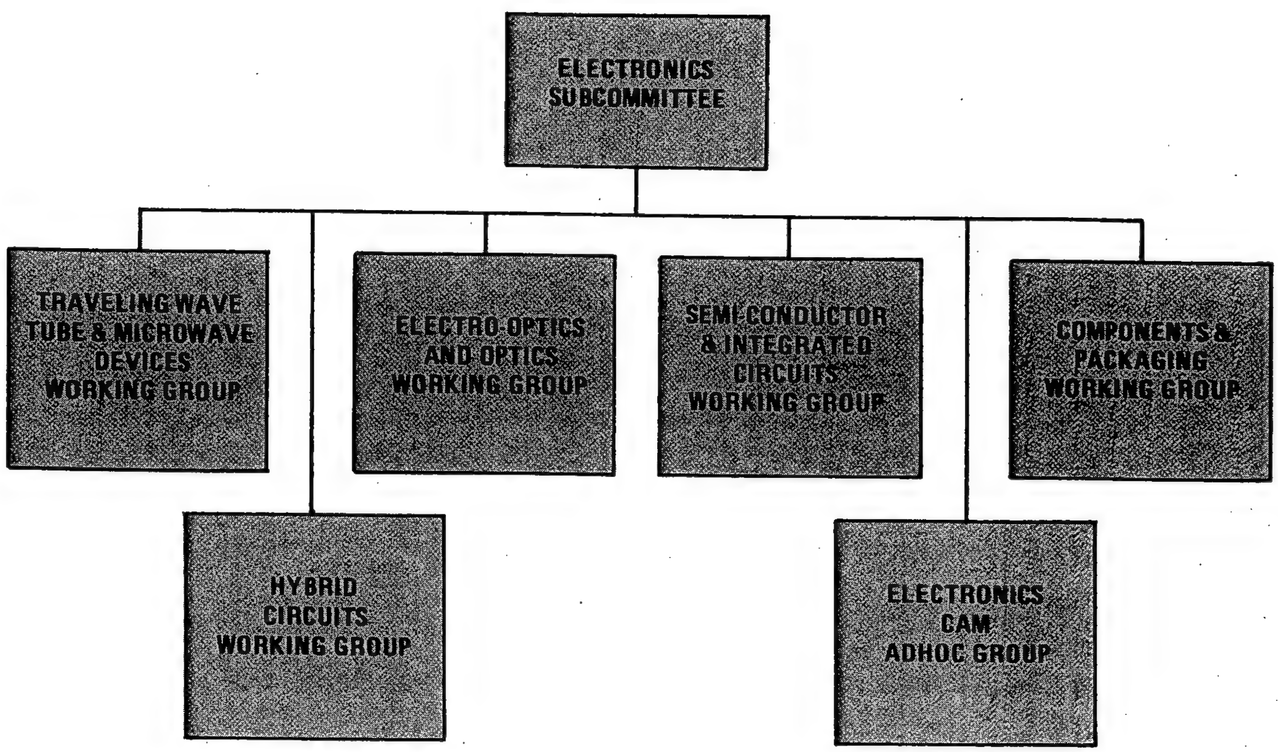
International Hybrids Society's Annual Meeting and discusses work of particular interest to the military. The **Components and Packaging Working Group** held its First Annual Planning Meeting at the same location and time as the International Packaging Conference. This back to back scheduling allows the same persons to attend both meetings and use civilian input to serve military needs. Also, there is little additional travel expense and time expended away from the office.

For the first time this year the **Traveling Wave Tube and Microwave Device Group** held its workshop following the Power Tube Conference at Monterey, California. And the **Electro-Optics Working Group** held its First Planning Meeting at the Night Visions Labs where much of its work is initiated and sponsored, while the **Semiconductor and Integrated Circuits Group** found it expedient to hold its sessions immediately after meetings of the Very High Speed Integrated Circuits (VHSIC) Steering Committee. While the **Electronics CAD/CAM Interface Group** has not yet held a formal technology planning conference, it is expected to be back to back with an Integrated Computer Aided Manufacturing (ICAM) meeting.

Changing Defense Requirements Play Role

The events that transpire during these Planning Conferences vary with the needs of the groups, but generally include an assessment of what new technologies are available and what new needs have surfaced as a result of changing defense requirements. By bringing together Tri-Service specialists and experts from the Electronic Industries Association and leading industrial firms, many short range problems can be solved immediately and solutions to long range problems worked out later. Plans and roadmaps are assembled or updated to show recent research and development progress, upcoming Manufacturing Technology efforts, and projected end item procurement schedules. The three—R&D, MT, and end items—must mesh together in a timely manner to be fully effective. Results to date have exemplified the practicality of this approach.

ELECTRONICS SUBCOMMITTEE



Triple Activity Format

Metals Subcommittee Provides Focal Point

Gordon B. Ney, Chairman

The Metals Subcommittee has proven to be an aggressive and dynamic force. During its six years of tenure, the Subcommittee has been responsible for eliminating six projects which would have duplicated previous work, forming fourteen multiservice projects, and hosting six workshops and seminars. These accomplishments reflect the hard work and cooperative spirit of the Subcommittee members.

Common Technologies Center Stage

We see our objective as providing a forum for the exchanging of technical information and ideas and maximizing the use of advanced manufacturing technology. We are attempting to prevent duplication, promote joint efforts where appropriate, and stimulate the application of advanced manufacturing technology to problem areas not previously considered. We deal with all processes required to produce metal and structural ceramic products, but concentrate on those technologies that are common, or—in our opinion—should be common, among the services. Concentrating on these technologies enables us to favorably influence the individual service programs in a way that each service, working by themselves, cannot.

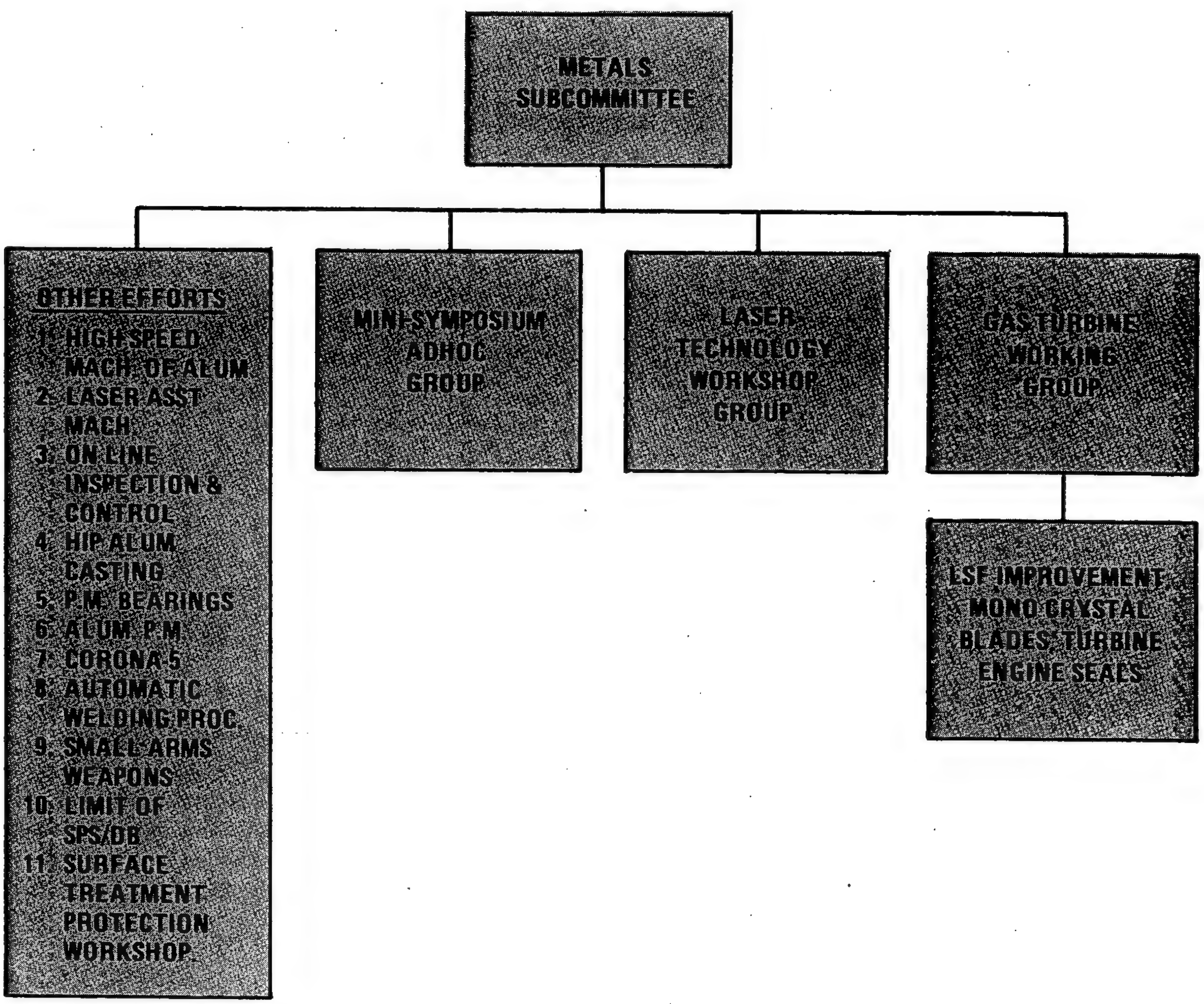
Three types of activities have evolved in accomplishing our objectives:

- Individual projects are reviewed to eliminate potential duplication of effort.
- Program data is analyzed and presented at the Annual MTAG Meeting to stimulate discussion concerning the trends occurring in the Services' programs.
- Workshops and seminars are sponsored to create a dialogue between DoD and Industry concerning program accomplishments and future directions.

Actions Assigned to Service Reps

We establish our activities for a given year through a process that begins with a Subcommittee meeting in late summer each year. At this meeting, the Services' budget, apportionment, and five year program plans are reviewed. Common areas of interest are identified and appropriate actions concerning them are recommended to the MTAG Executive Committee. Once approved, the actions are assigned to service representatives for execution. The results then are documented annually in the Metals Subcommittee report.

METALS SUBCOMMITTEE



Two Major Thrusts Considered

Non-Metals Subcommittee Takes Early Look

Robert C. Tomashot, Chairman

Membership of the Non-Metals Subcommittee is arranged so as to provide broad coverage of the Tri-Service Manufacturing Technology Program that involves both structural and nonstructural nonmetallic materials and the processes for their effective use in weapon systems. AMMRC and the aviation and missile commands of the Army; NAVSEA, NAVAIR, NAVORD, and NAVMIRO of the Navy; and AFWAL/ML and AFLC of the Air Force have provided continual technical specialists to the Subcommittee. Also, liaison members from NASA and DoE recently have been added.

Planning Two Years Ahead

From a program planning standpoint, the most beneficial results of Tri-Service coordination occurs on the FY +2 program. Thus, the usual mode of operation is to hold a summer meeting of the Subcommittee for a detailed review and examination of each Non-Metals ManTech project in its earliest stages of documentation. For example, in July of this year, the planned programs for FY 82 were reviewed by the Subcommittee for the purpose of eliminating any duplication of effort, suggesting improvements to the project, or establishing possible

joint or cooperative projects. After this type of review, written summary descriptions of the projects are furnished to the pertinent industry associations for their review, and a followup coordination meeting is held with industry association members for suggestions and comment. Other Subcommittee meetings are held during the year to review the status of ongoing projects. Periodically, major Tri-Service reviews of projects concerning non-metals manufacturing are held to completely update industry on the status and results of contractual programs. In addition, workshops are held on selected subjects such as the one on "In-Process Quality Control of Composite Materials/Fabrication" held in April 1980.

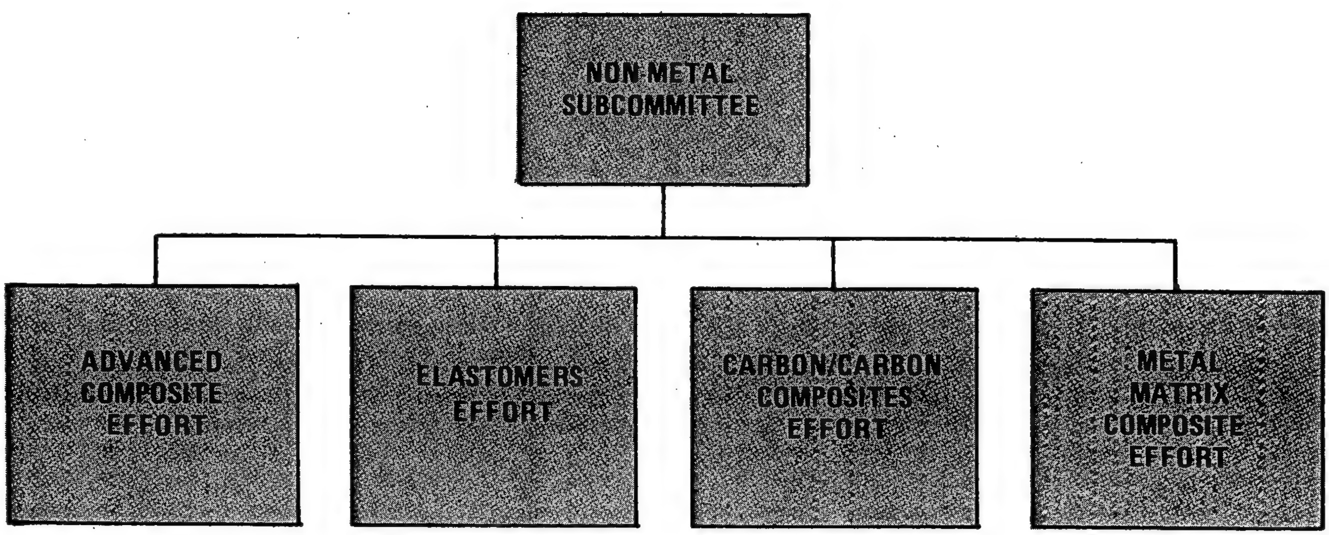
Cooperative Programs Result

Two of the major thrust areas to meet non-metals manufacturing requirements are structural composites fabrication and carbon-carbon materials processing.

- Structural composites application in aircraft and helicopter systems is continually expanding and manufacturing improvement goals common to all three services have led to several jointly funded, cooperative programs.
- The need for precisely manufactured carbon-carbon materials in missile reentry nosetips and rocket nozzle throats is also common to the three services and has resulted in cooperative programs to work selected areas of the total technology required.

It is expected that these areas will continue to be major thrust and interest areas to the three services and the Subcommittee. Industry comments and suggestions on programs to improve manufacturing technology in these areas as well as on any other subjects are welcome and can be submitted to the respective service contacts.

NON-METAL SUBCOMMITTEE



CY 1980

Anticipating Production Problems

Test & Inspection Subcommittee Improving Quality

Edward Criscuolo, Chairman

A preponderance of nondestructive testing projects over the past three years, especially in the intensely funded metals field, may reflect the trend in those areas of manufacturing technology covered by the Test and Inspection Subcommittee of MTAG. Potential tri-service programs in neutron radiography, automatic infrared inspection, and automatic ultrasonic inspection also are significant. The scope of the T&I responsibility covers a wide spectrum, including (besides the aforementioned) dimensional measurement via noncontact methods, composites with their complex characteristics, the dynamic demands of the electronics industry, munitions manufacturing that is sensitive to safety and reliability features, and increased use of computer aided inspection to improve on human interpretation. An increase in funding of 50% over the previous year has signalled what is ahead in this area of MTAG activity.

Large Technical Audience Served

The objectives of the Test and Inspection Subcommittee are as follows:

- To provide technical assessment and tri-service coordination of specific proposed manufacturing technology projects in the area of test and inspection. Through the examination of projects a determination is made for compatibility with DoD objectives, duplication of effort, and potential for joint funding.
- To provide an industry-government forum for the discussion of anticipated production problems and the identification of potential solutions and to assess the impact of privately sponsored work on the areas of interest.
- To make recommendations regarding joint service efforts, elimination of duplication, and establishment of broad DoD manufacturing technology goals in Test and Inspection.

Special Groups Provide Interface

The Subcommittee interfaces with each of the other subcommittees and therefore has been subdivided as shown in the accompanying chart. Four meetings were scheduled for 1980:

April 15-16	NAVMIRO Philadelphia, PA	Review plans for Minisymposium
July 29-31	NSWC Silver Spring, MD	1st Review of 1982 Submission
August 26-28	AMMRC Watertown, MA	2nd Review of 1982 Submission

September 10	NSWC Silver Spring, MD	MTAG XII Report
October 19-23	MTAG XII	Annual Meeting

Reviews Identify, Coordinate

A Review of the 1982 proposed projects served the purpose of:

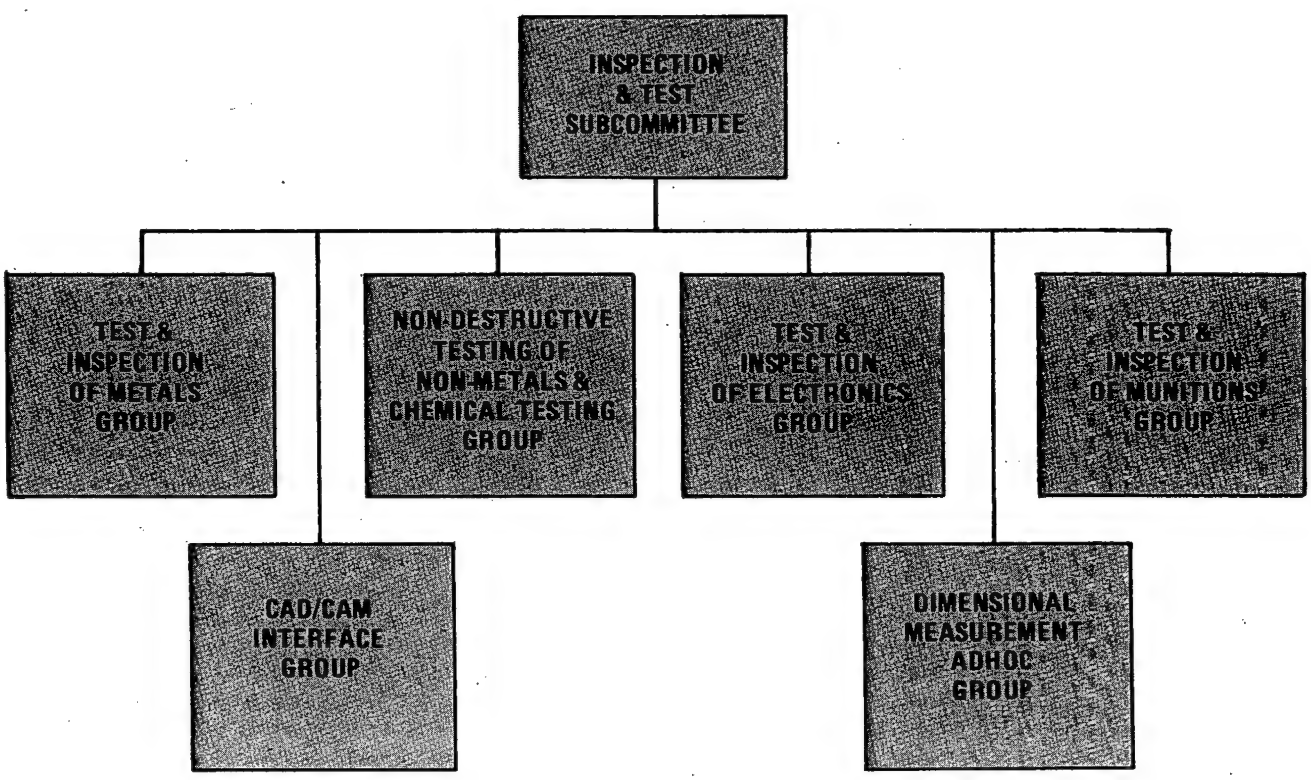
- Identifying potential duplication of proposed projects.
- Identifying overlaps where coordination of projects will be useful (joint programs).
- Identifying persisting Test and Inspection problems.
- Coordinating service efforts with those of industry.

Minisymposium to Feature Ten Titles

The Subcommittee has organized the following subjects for the Minisymposium of the 1980 Annual Conference:

— Eddy Current Surface Inspection of Discs
— Integrated Blade Inspection System (IBIS)
— In-Service Inspection System (ISIS)
— Mobile Neutron Radiography System
— Cannon Barrel Inspection
— Automatic Inspection Device for Explosive Charge in Shell (AIDECS)
— Gas Bearing Gyro Inspection System
— Angular Visual Security Test Set
— High Energy Real Time Radiography
— Detection of Cracks Under Fasteners

INSPECTION & TEST SUBCOMMITTEE



Commercial Impact Pronounced

Munitions Subcommittee Handles Full Spectrum

John Kaschak, Chairman

The MTAG Munitions Subcommittee is concerned with the full spectrum of triservice munitions manufacture. In achieving its multifaceted goals, the Subcommittee maintains close liaison with industry and other supportive areas of manufacturing technology. Subcommittee membership spans the three services, resulting in an unusually broad range of munitions expertise being applied to MT projects.

The primary responsibilities of the Munitions Subcommittee are to

- Assess and coordinate proposed MT projects for compatibility with DoD MT Program objectives, duplication of effort, and joint funding.
- Identify and propose solutions to anticipated production problems.
- Recommend areas of implementation and provide technology transfer for completed projects.
- Maintain knowledge of current state of the art production practices.
- Interact with industry to foster it as a useful resource for program planning, coordination, and implementation.

MM&T Projects Demonstrated

The Subcommittee has been involved with many varied projects to date. One area of popular interest has been the FAE II Die Casting and Skin Roll Forming MM&T Program. FAE II is an acronym for Fuel Air Explosive, 2nd generation, which is composed of two sizes of bombs—a 500 lb (BLU-95/B) and a 2000 lb (BLU-96/B). The FAE II MM&T Program is being developed on a triservice basis so that a potential $58M cost savings can be realized in production.

Basically, the FAE II Program is directed at two BLU-96/B high cost areas: the tailcone die casting die and the skin roll forming machine. The tailcone die is intended to replace the present sand mold casting techniques with a die casting die that is the most cost effective method of production. Die castings typically weigh 10 pounds or less, but as much as 50 pounds on rare occasion. In contrast, the BLU-96/B tailcone casting will weigh an estimated 72 pounds and will be the largest known die casting ever produced. The effort represents a significant advancement in die casting technology, with the die being about 21 feet high and weighing in excess of 60 tons. The technology demonstrates a capability of die casting large surface areas (12 square feet) of high strength (16,000 lb tensile) components.

In addition, a two roll form machine is being developed to roll form premachined, ten foot long aluminum sheets into BLU-96/B warhead fuel container skins. The machine is the largest two roll machine ever built—sixteen feet long, thirteen feet deep, and five feet high. The two roll form machine is much more cost effective than three roll machines because protective coatings are not damaged,

additional forming required by three roll machines is eliminated, and all secondary machining is eliminated since a premachined sheet can be used.

Planning Meetings Held

The activities of the Munitions Subcommittee were structured around three General Meetings and two tech demos in 1980 as follows:

(1) General Meeting, "Focusing the CY80 Program," ARRADCOM, Dover, N.J.;

(2) General Meeting, Review of "Tri-Service FY-81/82 MMT Program", "Formulation of Conference Technology," ARRADCOM, Dover, N.J.;

(3) General Meeting, "Dry Run Annual Conference Presentations," ARRADCOM, Dover, N.J.;

(4) Tech Demo during (1) above: "Continuous Melt-Pour Controlled Cooling Prototype Facility";

(5) Tech Demo during (2) above: "Drying of Low Density Ball Propellant".

MTAG MUNITIONS SUBCOMMITTEE

Date	Project Title/Location	[illegible]
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October	[illegible]	[illegible]
November	[illegible]	[illegible]

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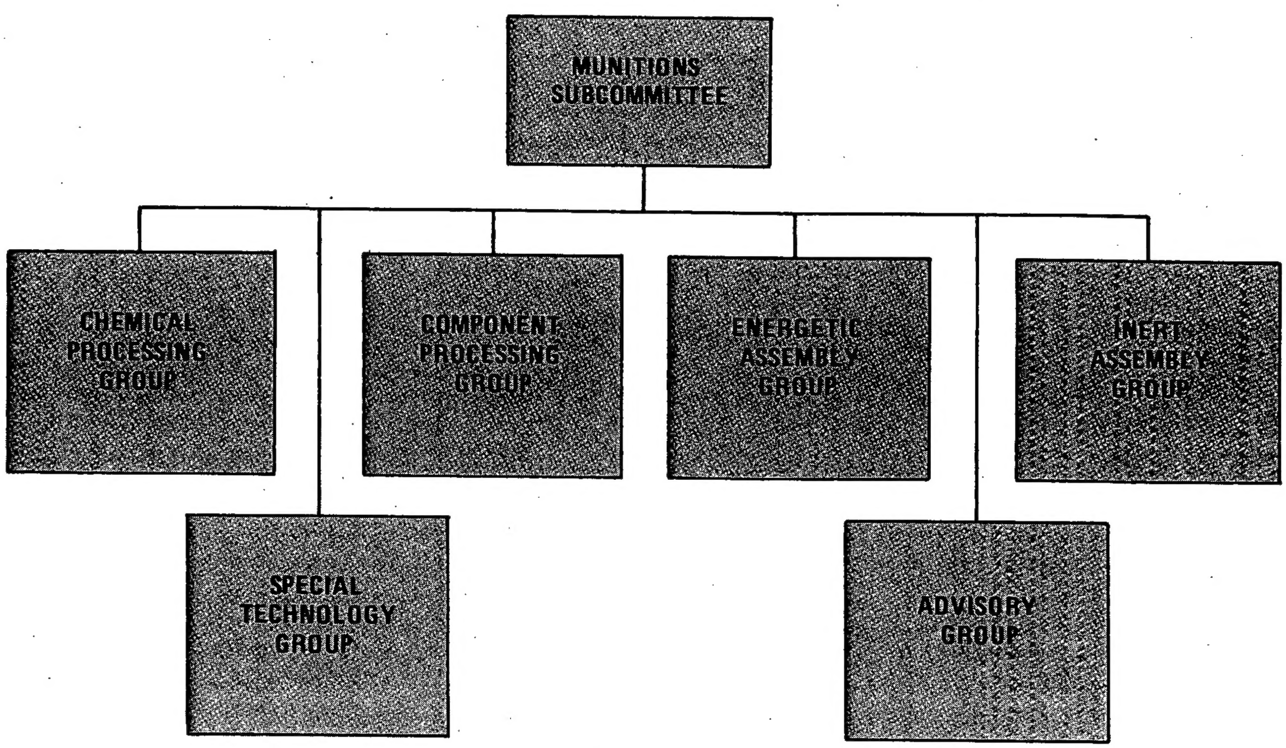
MUNITIONS SUBCOMMITTEE



DEPARTMENT OF DEFENSE
Washington, D.C.

STATEMENT OF PRINCIPLES
FOR
DEPARTMENT OF DEFENSE
MANUFACTURING TECHNOLOGY PROGRAM

PROGRAM OBJECTIVES. *The productivity and responsiveness of our Defense industrial base is a key element of our national security and military posture. The Manufacturing Technology Program's objective is to significantly improve the productivity and responsiveness of the industrial base by engaging in initiatives which:*

- *Aid in insuring the economical production of qualitatively superior weapon systems on a timely basis*
- *Insure that advanced manufacturing processes, techniques, and equipment are used to reduce DoD materiel acquisition costs*
- *Continuously advance manufacturing technology to bridge the gap from R&D advances to full-scale production*
- *Foster greater use of computer technology in all elements of manufacturing*
- *Assure that more effective industrial innovation is stimulated by reducing the cost and risk of advancing and applying new and improved manufacturing technology*
- *Assure that manufacturing processes are consistent with safety and environment considerations and energy conservation objectives*

ROI CONSCIOUSNESS. *A deeper and more explicit consciousness of Return on Investment must be developed and used by all levels of management of the Manufacturing Technology Program. We must assure the high leverage Return on Investment potential of the DoD Manufacturing Technology Program is realized.*

PROGRAM PLANNING. *Industrial base needs must be identified and manufacturing technology projects programmed to meet these requirements. Program planning must constitute a fully integrated tri-Service activity. Individual manufacturing technology project planning must be well thought out, given wide spread visibility, and provide a mechanism for senior management personnel to impact the project content and priorities.*

IMPLEMENTATION AND TECHNOLOGY TRANSFER. *Full benefit from the program can only be achieved if its plans, progress, and results are readily available to DoD and the industrial base in a timely and convenient manner. Implementation and technology transfer of project results are critical elements of Manufacturing Technology Program management.*

EVALUATION. *The Manufacturing Technology Program must be routinely and continuously evaluated to measure its effectiveness. Program benefits must be documented by each Service in clear, simple and unequivocal terms.*

PROJECT SELECTIVITY. *We must assure maximum benefits from every manufacturing technology dollar invested. We must insure that:*

- *Technical feasibility has been previously demonstrated before procurement-funded manufacturing technology projects are initiated*
- *There is a well-defined DoD requirement for the technology and that it can be delivered in time to meet that requirement*
- *Private industry cannot or will not make the investment in the time frame required*
- *Anticipated project results are generic.*

ASSESSMENT OF NEEDS. *Manufacturing Technology Program investments should be determined by assessing both the generic production-related life-cycle-costs and the potential contribution of existing and emerging technologies to reduce those costs.*

PROGRAM MANAGEMENT. *Each Service will provide strong central program management to promote the requisite centralized fiscal planning and control necessary for direction and orientation of the program to the areas of greatest need and payoff. Multi-Service investments are encouraged. Program Managers will be encouraged to include new manufacturing technology in their acquisition strategies.*

Arden L. Bement, Jr.
Deputy Under Secretary of Defense
for Research and Engineering
(Research & Advanced Technology)

Dale W. Church
Deputy Under Secretary of Defense
for Research & Engineering
(Acquisition Policy)

Percy A. Pierre
Assistant Secretary of the Army
(Research, Development & Acquisition)

Joseph A. Doyle
Assistant Secretary of the Navy
(Manpower, Reserve Affairs & Logistics)

Robert J. Hermann
Assistant Secretary of the Air Force
(Research, Development & Logistics)

MARCH 14, 1980

PURPOSE OF THE MANTECH JOURNAL

To accelerate exchange of information about new manufacturing technology thru reports on manufacturing and management techniques newly implemented by the Army. Communication will be enhanced within the Army scientific community, with other Government R&D agencies, and with industry—particularly all those who are deeply involved in modernizing our manufacturing base in the United States. Army R&D activities will become more widely known, resulting in more cost-effective overall research and development programs both in the military and in industry.

Readers are asked to address all correspondence to Dr. John J. Burke, Editor, U.S. Army Materials and Mechanics Research Center, Arsenal Street, Watertown, Massachusetts 02172.